DEUTSCHE internationale Zeitschrift

für zeitgenössische Wissenschaft

№129
2026

DIZZW 2020

DEUTSCHE internationale Zeitschrift
für zeitgenössische Wissenschaft

DIZZW 2020

DEUTSCHE internationale Zeitschrift
für zeitgenössische Wissenschaft

ISSN (Print) 2701-8369
ISSN (Online) 2701-8377

Deutsche internationale Zeitschrift für zeitgenössische Wissenschaft

• • •

№129 2026

German International Journal of Modern Science

• • •

№129 2026

Deutsche internationale Zeitschrift für zeitgenössische Wissenschaft ist eine internationale Fachzeitschrift in deutscher, englischer und russischer Sprache.

Periodizität: 24 Ausgaben pro Jahr
Format - A4
Alle Artikel werden überprüft.
Freier Zugang zur elektronischen Version des Journals

German International Journal of Modern Science is an international, German/English/Russian/Ukrainian language, peer-reviewed journal.

Periodicity: 24 issues per year
Format - A4
All articles are reviewed.
Free access to the electronic version of journal.

- Edmund Holst (Salzburg) AT
- Michaela Meissner (Köln) DE
- Klara Amsel (Liège) BE
- Briana French (Cambridge) GB
- Joleen Parsons (Manchester) GB
- Dragomir Koev (Sofia) BG
- Stanislav Štěpánek (Praha) CZ
- Valeriya Kornilova (Kyiv) UA
- Dmitriy Aksenov (Lviv) UA
- Valentin Bragin (Moscow) RU
- Mirosław Bednarski (Warsaw) PL
- Daniela Villa (Florence) IT
- Mattia Molteni (Rome) IT
- Sylwia Krzemińska (Ljubljana) SI
- Käte Kraus (Vienna) AT
- Eleonora Lehmann (Berlin) DE
- Alexander Dressler (Marseille) FR
- Zdzisław Małecki (Warsaw) PL
- Adrián Borbély (Budapest) HU

- Edmund Holst (Salzburg) AT
- Michaela Meissner (Köln) DE
- Klara Amsel (Liège) BE
- Briana French (Cambridge) GB
- Joleen Parsons (Manchester) GB
- Dragomir Koev (Sofia) BG
- Stanislav Štěpánek (Praha) CZ
- Valeriya Kornilova (Kyiv) UA
- Dmitriy Aksenov (Lviv) UA
- Valentin Bragin (Moscow) RU
- Mirosław Bednarski (Warsaw) PL
- Daniela Villa (Florence) IT
- Mattia Molteni (Rome) IT
- Sylwia Krzemińska (Ljubljana) SI
- Käte Kraus (Vienna) AT
- Eleonora Lehmann (Berlin) DE
- Alexander Dressler (Marseille) FR
- Zdzisław Małecki (Warsaw) PL
- Adrián Borbély (Budapest) HU

Artmedia24

Anschrift: Industriestraße 8,74589 Satteldorf Deutschland.

E-mail: info@dizzw.com
WWW: www.dizzw.com

Chefredakeur: Reinhardt Roth

Druck: Einzelfirma Artmedia24, Industriestraße 8,74589 Satteldorf Deutschland

Artmedia24

Address: Industriestrasse 8,74589 Satteldorf Germany.

E-mail: info@dizzw.com
WWW: www.dizzw.com

Editor in chief: Reinhardt Roth

Printing: Artmedia24, Industriestrasse 8,74589 Satteldorf Germany.

Der Redaktionsausschuss der Zeitschrift ist nicht verantwortlich für die veröffentlichten Materialien.

Für den Inhalt der Artikel sind die Autoren verantwortlich
Die Meinung der Redaktion spiegelt nicht unbedingt die Meinung der Autoren wider.

Bei Nachdrucken muss die Zeitschrift zitiert werden.

Das Material wird im eigenen Wortlaut des Autors veröffentlicht.

Editorial board of journal is not responsible for the materials published there.

Authors are responsible for the content of articles.

Opinion of editorial board may not coincide with the opinion of authors.

In case of materials reprinting - link to journal is required.
Materials are publishing in author's edition.

Edition: № 129/2026 (May) – 129th

Passed in press in May 2026

Printed in May, 2026

Printing: Artmedia 24, Industriestrasse 8,

74589 Satteldorf, Germany.

© Artmedia24

© Deutsche internationale Zeitschrift für zeitgenössische Wissenschaft / German International Journal of Modern Science

CONTENT

AGRICULTURAL SCIENCES

Vakhtang Kobalia, Nino Kipiani
"ADREULA" MANDARIN IN RELATIVELY SEVERE CONDITIONS OF CITRUS CULTIVATION 5

CHEMICAL SCIENCES

Yurii Klimko, Iryna Koshchii
SYNTHESIS OF 1-[4-(1-ALAMANTYL) PHENYL]−4-ACETYL-5-METHYL-1,2,3-TRIAZOLE - A NEW REAGENT FOR THE SYNTHESIS OF HYBRIDS 8

EARTH SCIENCES

Arushanov M.L., Eshmuratova G.Sh.
LONG-TERM DROUGHT FORECAST IN UZBEKISTAN BASED ON A DYNAMIC-STOCHASTIC ROOT MODEL 11

ECONOMIC SCIENCES

David Bidzinashvili, Tea Khorguashvili
ACTIVATION OF TRADE RELATIONS AND GEORGIA'S STRATEGIC ROLE IN CARGO TRANSPORTATION THROUGH THE MIDDLE CORRIDOR 18

Uakhit Kamila Asankyzy
PERCEPTIONS AND ADOPTION BARRIERS OF AI IN ACCOUNTING FIRMS: RESEARCH ON KAZAKHSTAN VS. GLOBAL RESULTS.....20

Natia Zhozhuashvili, Nino Orjonikidze
DIGITAL MARKETING TRANSFORMATION IN THE HOTEL BUSINESS AND ITS MODERN TRENDS IN GEORGIA.....22

Svetlin Minev
ASSOCIATION BETWEEN CORPORATE FINANCIAL PERFORMANCE AND ESG RATINGS OF PUBLIC COMPANIES: AGGREGATE REGRESSION ANALYSIS ...30

JURISPRUDENCE

Khurtsilava Robizon, Khurtsidze Daviti
THE IMPACT OF THE JUDGMENTS OF THE EUROPEAN COURT OF HUMAN RIGHTS ON THE IMPLEMENTATION OF CIVIL PROCEDURAL NORMS .33

Giorgi Kvaratskhelia
CORRUPTION" AGAINST BATTLE LEGAL AND INSTITUTIONAL MECHANISMS COMPARATIVE ANALYSIS: GEORGIA AND DEVELOPED COUNTRIES "40

Lela Gudadze, Amiran Mosulishvili
OFFICIAL MISCONDUCT AND ITS LEGAL CONSEQUENCES.....45

Teona Giorgadze
THE LEGAL NATURE AND OPERATIONAL SPECIFICITIES OF DOCUMENTARY LETTERS OF CREDIT: CONTEMPORARY CHALLENGES AND WAYS FORWARD 51

PEDAGOGICAL SCIENCES

Lola Salimbekovna Gafarova
THE INTRODUCTION OF BLENDED LEARNING TECHNOLOGIES INTO RUSSIAN LANGUAGE TEACHING (USING THE LEARNINGAPPS.ORG PLATFORM AS AN EXAMPLE).....54

Atamirzayeva Ezoza Bekmirzayevna
THE PSYCHOLINGUISTIC NATURE OF ORAL SPEECH ACTIVITY AND ITS PEDAGOGICAL INTERPRETATION 57

PHILOLOGICAL SCIENCES

Roya Zeynalova
HOW COGNITIVE LINGUISTICS CAN HELP VOCABULARY TEACHING.....59

Alı Hashımov, Anar Abuzarli
THE RESTORATION OF ARCHETYPAL MEMORY IN THE CREATIVE WORK OF ISA MUGHANNA.....62

Mammadova Rubaba, Qasimzade Inji, Babayeva Ayshen, Jafarova Qizkhanum
FROM TRADITION TO TECHNOLOGY: MODERN WAYS OF LEARNING ENGLISH 67

Aliyev Ceyhun, Akhundov Ayaz, Aliyev Salman
POST-EXECUTION PUNISHMENT AND THE POLITICS OF HELP: DEATH PENALTY, PATRIARCHAL POWER, AND RESTORATIVE FAILURE IN BALLAD OF A WHITE COW 71

PHYSICAL SCIENCES

Gurevich G., Ilyev O.
PROOF OF THE ABSENCE OF CENTRIPETAL FORCE AND CENTRIPETAL ACCELERATION WHEN A BODY MOVES ALONG A CURVILINEAR TRAJECTORY.....73

POLITICAL SCIENCES

Khatuna Nebieridze, Giorgi Momtselidze
PUBLIC SCHOOL IN THE DIGITAL AGE.....79

TECHNICAL SCIENCES

Berestovoi I.
FEATURES OF THE PRACTICAL IMPLEMENTATION OF SIMULATION TECHNOLOGIES IN TEACHING ELECTRICAL ENGINEERING DISCIPLINES IN BLENDED LEARNING CONDITIONS 86

Damir Syzdykov, Selcuk Cankurt
STUDENT PERFORMANCE PREDICTION USING MACHINE LEARNING 89

VETERINARY SCIENCES

Mykola Bogach, Nadiia Selishcheva, Denys Bohach, Olena Kolchyk, Olena Bohach
STATE OF INTESTINAL MICROBIOCENOSIS AND BIOCHEMICAL BLOOD PARAMETERS OF CHICKENS UNDER FEEDING WITH FEED CONTAMINATED BY BIOTIC FACTORS AND THE USE OF CAMBRIAN CLAY 100

AGRICULTURAL SCIENCES

"ADREULA" MANDARIN IN RELATIVELY SEVERE CONDITIONS OF CITRUS CULTIVATION

Vakhtang Kobalia
Academic Doctor of Agriculture, Emeritus,
Akaki Tsereteli State University, Kutaisi, Georgia.
Nino Kipiani
Academic Doctor of Agriculture, Associate Professor,
Akaki Tsereteli State University, Kutaisi, Georgia.
DOI: 10.5281/zenodo.20606918

Abstract
The further development of citrus growing in Georgia requires the establishment of mandarin plantations even in relatively severe conditions of crop cultivation through the introduction of appropriate varieties. The paper discusses the results of studying the fruiting and some agrobiological indicators of one of the promising varieties for this purpose - "Adreula" mandarin. The prospect of the Adreula variety in this direction is confirmed by the fact that, compared to the standard variety, it is medium-growing, ripens fruits 20-25 days earlier, has high productivity (19-21% more), and high quality indicators of fruits.

Keywords: Mandarin, variety, productivity, fruit, growth.

Introduction. Further development of citrus growing in Western Georgia, along with other agrotechnical measures, implies the further expansion of mandarin plantations in relatively severe conditions of cultivation through the selection and introduction of appropriate varieties and forms [1]; [2].

Broad-leaved Unshiu mandarin, which is the main production variety in Western Georgia, although CHARACTERIZED by relatively high frost resistance and high yield, creates problems for wide distribution in relatively harsh conditions due to late fruit ripening (November-December) - it does not manage to ripen the fruit, is easily damaged by frosts, productivity is low, etc. [3]; [4].

As for the introduced and local early varieties implemented in production (Kovano-Wase, Miyagawa-Wase, Georgian Early, and others), although they manage to ripen the fruit before the onset of harsh climatic conditions, they are characterized by low yield due to dwarf growth, as well as relatively weak frost resistance [4]; [5].

The new early mandarin variety "Adreula," studied by us in the 90s of the last century in the conditions of Abkhazia, which is medium-growing, high-yielding, and relatively frost-resistant Appears to us as a very interesting variety in this direction [5]; [6]. Therefore, we aimed to determine some features of its growth-development and fruiting in the conditions of Kutaisi and Nosiri (Senaki district).

Material and Methodology. Mature plants of the mandarin variety "Adreula" (experimental) of nucellar origin, obtained by crossing Miyagawa-Wase mandarin with *Citrus ichangensis,* and broad-leaved Unshiu mandarin (control) were taken as the objects of research.

Observations were carried out at the experimental plots of the Scientific-Research Laboratory of Citrus Selection and Genetics of the Faculty of Agronomy of Akaki Tsereteli State University (Kutaisi) and the educational-research farm of Nosiri (Senaki district) of the same faculty. The number of plants is 15-15 units, all grafted on *Poncirus trifoliata* rootstock and planted with a 2 x 4 m feeding area in 2013.

Phenological observations, biometric measurements, yield recording, and study of fruit quality indicators were carried out on the research plants.

Biological characteristics of plants were studied through recording and observation: early maturity - by recording changes in fruit coloration; phenological phases of plant growth and development - by generally accepted methodology; yield - by counting and weighing fruits; biochemical composition - by the method of High-Performance Liquid Chromatography. [7].

Research Results. The results of three-year (2021-2023) observations showed that, compared to the broad-leaved Unshiu mandarin, plants of the Adreula variety ripen fruits on average 20-25 days earlier on both experimental plots. They enter into bearing in the third year, i.e., one year earlier compared to the Unshiu mandarin. The average height of a 10-year-old plant of the experimental variety under Kutaisi conditions is equal to 2.05 meters, while under Nosiri conditions 2.15 meters, whereas the height of the control plant under Kutaisi conditions averages 2.45 cm, and under Nosiri conditions - 2.55 cm.

Mandarin Adreula exhibits high fruit-bearing capacity on both experimental plots. Observation of fruit bearing over three years, (Table 1) showed that 2021 was the lowest-yielding year, while 2023 was the highest-yielding. On the Kutaisi experimental plot in 2021, 358,5 kg of fruit was harvested from 15 trees of Mandarin Adreula; the productivity of one plant amounted to 303,3 units, or 23,9 kg of fruit. In the same year, 284 kg of fruit was harvested from 15 trees of Unshiu mandarin, which, calculated per plant, amounts to 252,7 units, or 18,9 kg of fruit. Thus, in 2021 the fruit-bearing of Mandarin Adreula exceeded the same indicator of the control variety by 110,6%. In 2023, the mass of fruits harvested from all plants of Mandarin Adreula amounted to 438,2 kg, and the productivity - 370,6 units and 29,2kg, respectively. In the same year, 396,0

kg of fruit was harvested from 15 trees of Unshiu mandarin. Productivity reached 357,2 units, or 26,4 kg of fruit.

Table 1

Productivity indicators of research plants by years

Name of research plants	Years of observation	Name of the experimental plot					
		Kutaisi			Nosiri		
		Yield of 15 roots	unit	kg	Yield of 15 roots	unit	kg
Mandarin Unshiu (Control)	2011	284.0	252.7	18.9	336.0	297.4	22.4
	2012	334.5	300.5	22.3	339.1	357.0	26.6
	2013	396.0	357.2	26.4	436.5	395.2	29.1
	Avg.	338.1	303.5	22.5	370.5	349.9	26.0
Mandarin Adreula (Experimental)	2011	358.5	303.3	23.9	393.1	323.2	26.2
	2012	421.5	363.9	28.1	483.1	418.7	32.2
	2013	438.2	370.6	29.2	532.5	472.1	35.5
	Avg.	406.0	346.9	27.0	469.5	404.6	31.3
% compared to control	2011	126.2	120.0	126.5	116.9	108.7	117.0
	2012	126.0	121.1	126.0	142.5	117.3	120.0
	2013	110.6	103.8	110.6	121.9	119.5	121.9
	Avg.	120.9	114.9	121.0	127.1	115.2	119.6

This year, according to fruit-bearing, the difference among the studied plants in favor of the early variety amounted to 126.0%. Based on the analysis of three-year yields, it can be said that on the **Kutaisi** experimental plot, **Mandarin Adreula** plants exhibit a higher fruit-bearing capacity than **Mandarin Unshiu** plants. In these years, the productivity of **Mandarin Adreula** was 27.0 kg, while **Mandarin Unshiu** was 22.5 kg, i.e., 121.0% more.

Almost identical results were obtained at the **Nosiri** experimental plot If we take the three-year indicators, we will see that 15 **Mandarin Adreula** plants yield 469.5 kg of fruit, which, when calculated per plant productivity, amounts to 404.6 units, or 31.3 kg of fruit, while the same indicators for the control plant are 370.5 kg, 349.9 units, and 26.0 kg, respectively, which is 19.6% more in favor of the early variety.

Thus, on both experimental plots, the productivity of **Mandarin Adreula** plants is 19.6-21.0% higher than that of the control plants. Furthermore, if we take into account that **Mandarin Adreula** fully ripens its fruits before the onset of harsh climatic conditions, while **Mandarin Unshiu** does not manage to ripen fully, **Adreula** is unconditionally promising for establishing mandarin plantations in harsh cultivation conditions. This is also confirmed by the qualitative indicators of the fruits studied by us (Table 2).

Table 2

Mechanical and biochemical composition of the fruits of the studied plants (2023 data)

Location	**Name of the studied plants**	**Fruit weight, g**	**Fruit dimensions**			**Fruit composition, %**			**Dry matter**	**Vitamin "C"**	**Acidity, %**	**Total sugar**
			Height	**Diameter**	**Skin**	**Pulp**	**Skin**	**Seed**				
Kutaisi	Mandarin Adreula (Experimental)	74.2	3.9	4.7	2.2	76.9	23.1	0	11.2	34.0	0.9	6.4
	Mandarin Unshiu (Control)	72.9	3.8	4.5	2.2	75.5	24.5	0	10.6	31.2	1.1	6.2
Nosiri	Mandarin Adreula (Experimental)	77.8	4.0	4.7	2.3	77.2	22.8	0	11.5	33.2	0.9	6.5

Location	Name of the studied plants	Fruit weight, g	Fruit dimensions			Fruit composition, %			Dry matter	Vitamin "C"	Acidity, %	Total sugar
			Height	Diameter	Skin	Pulp	Skin	Seed				
	Mandarin Unshiu (Control)	74.0	4.0	4.6	2.3	75.9	24.1	0	10.7	32.3	1.1	6.2

From the mechanical and biochemical analysis of the fruits of the studied plants, it appears that **Mandarin Adreula** fruits are distinguished by high indicators in this regard on both experimental plots. Specifically, the fruit mass in **Kutaisi** conditions averages 74.2 g, while in **Nosiri** conditions it is 77.8 g, whereas in 'Unshiu' it is equal to 72.9 and 74.2 g, respectively. The pulp yield in the fruits of the experimental variety is 76.9% and 77.2% according to the plots, while in the control it is 75.5% and 75.9%. The fruits of all plants are seedless. In 'Adreula' fruit, dry matter constitutes 11.2-11.5%, Vitamin "C" 33.2-34.0 mg/100g, acidity 0.9%, and total sugars 6.4-6.5%. All these indicators are much better than in the fruits of 'Unshiu' mandarin.

Conclusion. Based on the above, it can be concluded that in relatively harsh conditions of mandarin cultivation, the early mandarin variety 'Adreula' is more promising, which is medium-growing, ripens fruits 20-25 days earlier compared to the broad-leaved 'Unshiu' mandarin, enters bearing one year earlier, and their productivity is 19.6-20.0% higher; also, the qualitative indicators of the fruits are the best.

References

1. Baratashvili, Khalvashi 2016: D. Baratashvili, N. Khalvashi. Biological diversity and genetic resources of citrus in Georgia. Publishing House "Batumi Shota Rustaveli State University", Batumi, 2016, pp. 234-289.

2. Jobava T., Kobalia V. 2007. Lemon Dioskuria and Mandarin Adreula-promising selection varieties. Bulletin of the Academy of Agricultural Sciences of Georgia, Vol. 20, Tbilisi, 2007, pp. 94-96.

3. **Kipiani N., Tutberidze B.** 2010. Perspectives of practical use of distant hybrids of citrus plants. Subtropical Crops, 2010, No. 1-4, pp. 23-27.

4. **Kobalia V.** 2016. "Results of the study of biomorphological and economic indicators of the diversity of forms of nucellar seedlings of 'Adreula' MANDARIN". Periodic Scientific Journal **AgroNEWS**, No. 1, 2016, 42-47

5. Nino Davit Kipiani „The Emergence of Hybrid Seeds and Polyembryony in Some Citrus Cultigens'' JLS „Journal of Life Sciences''. Volume 8, Number 7, July 2014 ISSN 1934-7391 (Print) ISSN 1934-7405 (Online) David Publishing company.www.davidpublishing.com. Impact Factor New York, NY 10034, USA (Aims and Scope)Pg. 603-604

6. *Roland Kopaliani*, Nino Kipiani*, Shorena Kapanadze*, Julieta Sanikidze „Some Aspects of Growth and Development of Hybrid Citrus Seedlings Obtained through Distant Hybridization ISSN - 0132 – 1447*
http://science.org.ge/bnas/vol-19-2.html
http://science.org.ge/moambe/moambe-geo.html VOL 19 N2 2025 139-141 science.org.ge

7. Kobalia V. 2018. Biochemical characterization of promising clones of early mandarin. Bulletin of the Academy of Agricultural Sciences of Georgia, No. 21(40), Tb., 2018, pp. 51-54.

CHEMICAL SCIENCES

SYNTHESIS OF 1-[4-(1-ALAMANTYL) PHENYL]−4-ACETYL-5-METHYL-1,2,3-TRIAZOLE - A NEW REAGENT FOR THE SYNTHESIS OF HYBRIDS

Yurii Klimko
PhD in Chemistry, Senior Lecturer
Department of Organic Chemistry and Technology of Organic Substances
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"
Iryna Koshchii
PhD in Chemistry, Associate Professor
Department of Organic Chemistry and Technology of Organic Substances
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"
DOI: 10.5281/zenodo.20606998

Abstract
The discovery of single-molecule therapeutics capable of simultaneously combating antibiotic resistance and neurodegenerative diseases represents a critical unresolved challenge in modern medicinal chemistry. This paper describes an efficient synthesis of a new 1-adamantyl-containing reagent for the preparation of various 1,2,3-triazole hybrids as bioactive agents with dual targets. 1,2,3-Triazole-based hybrids represent a versatile and previously understudied structural class for the development of dual-target drugs, and demonstrate significant potential for further optimisation in the development of comprehensive therapeutic strategies against antibiotic-resistant infections and neurodegenerative diseases.

Keywords 1,2,3-triazol, multicomponent reaction synthesis, antimicrobial activity, 1-adamantyl.

Introduction

Antibacterial resistance has become one of the most serious global health threats, significantly reducing the effectiveness of conventional antibiotic therapy. Among resistant pathogens, Staphylococcus aureus is a leading cause of both community-acquired and hospital-acquired infections. In particular, methicillin-resistant Staphylococcus aureus (MRSA) strains have developed resistance to multiple β-lactam antibiotics, making treatment increasingly difficult and contributing to higher morbidity and mortality rates. Therefore, the identification and development of novel antibacterial agents effective against both methicillin-sensitive Staphylococcus aureus (MSSA) and MRSA remain an urgent priority in antimicrobial drug discovery [1,2].

Alzheimer's disease (AD) is a progressive and irreversible neurodegenerative disorder that represents a major global public health challenge associated with population aging.

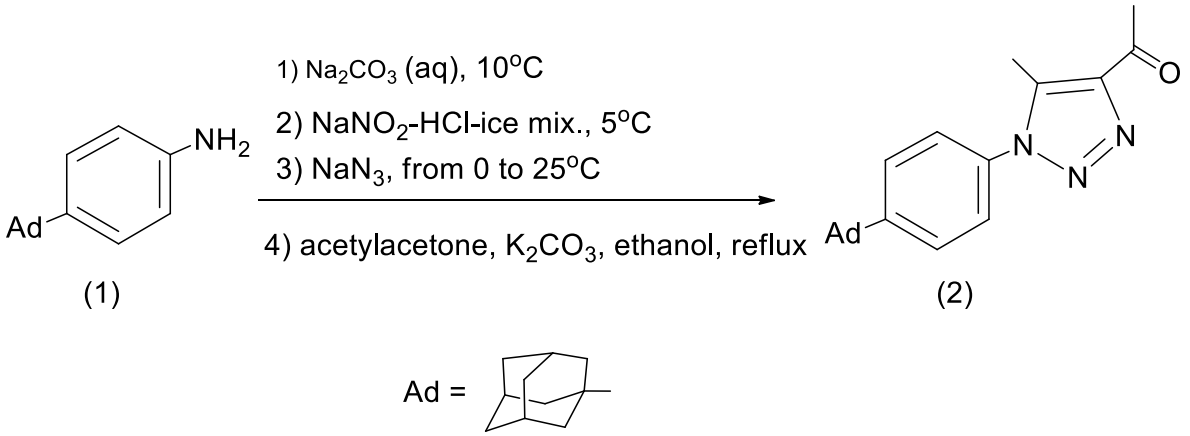
In recent years, heterocyclic compounds have attracted considerable attention in drug discovery due to their structural diversity and broad spectrum of biological activities [3]. Among them, triazole derivatives have emerged as particularly valuable scaffolds in medicinal chemistry [4]. These compounds exhibit a wide range of pharmacological properties, including anticancer [5], antitubercular [6], antiviral [7], anti-inflammatory [8], antimicrobial [9], and anti-Alzheimer activities [10]. Their versatility is attributed to their unique physicochemical properties and their ability to interact effectively with biological macromolecules [11].

An important strategy in modern medicinal chemistry involves the design of hybrid molecules that combine two or more biologically active pharmacophores within a single molecular framework. Such a hybridization approach can enhance biological activity, improve selectivity, and reduce toxicity by exploiting synergistic interactions between different structural motifs. Numerous studies have demonstrated that hybrid compounds containing a 1,2,3-triazole scaffold often exhibit significantly enhanced biological activity compared with their parent structures.

Materials and Methods

Instruments and Chemicals

All chemicals and solvents used in the experimental procedures were purchased commercially from Aldrich or Merck and were used without further purification unless otherwise specified. Melting points (m.p.) were determined using an Electrothermal 9100 capillary melting point apparatus and are reported uncorrected. IR spectra were recorded in the range of 4000–400 cm^{-1} using a PerkinElmer 55148 Fourier-transform infrared (FT-IR) spectrometer. The ^{1}H and ^{13}C NMR spectra were obtained in DMSO-d_6 or $CDCl_3$ using tetramethylsilane (TMS) as an internal standard on a Bruker 600 MHz NMR spectrometer. Elemental analyses (C, H, N) were performed using a Thermo Flash 2000 organic elemental analyzer (CHN). Absorbance measurements were carried out at 517 nm using a Shimadzu UV-1800 spectrophotometer.



***Scheme 1**. Synthesis of 1-[4-(1-adamantyl phenyl]−4-acetyl-5-methyl-1,2,3-triazoles (2)*

Synthesis of 1-[4-(1-adamantylphenyl)]-4-acetyl-5-methyl-1,2,3-triazole (2)

A 100 mL two-neck round-bottom flask was charged with p-substituted aniline (10 mmol) and sodium carbonate (5 mmol), and the mixture was stirred in an ice bath. Separately, $NaNO_2$ (10 mmol) was dissolved in 2 mL of distilled water, while concentrated HCl (2 mL) was mixed with 2 mL of distilled water. This solution was added dropwise to the reaction flask while carefully maintaining the temperature to prevent a rapid increase. Sodium azide (NaN_3, 10 mmol) was then added, and the reaction mixture was allowed to warm spontaneously to room temperature (~25 °C). After reaching the desired temperature, acetylacetone (10 mmol), potassium carbonate (15 mmol), and 15 mL of ethanol were added, and the mixture was refluxed for 1–4 h (Scheme 1). The progress of the reaction was monitored by thin-layer chromatography (TLC). Upon completion, the reaction mixture was cooled to room temperature and poured into an ice–water mixture with stirring. The resulting precipitate was filtered, washed with cold water, and recrystallized from absolute ethanol.

Yellowish solid; mp 122–124 °C; yield: 3.35 g (quantitative); Rf = 0.46 (n-hexane/ethyl acetate, 2:3); IR (KBr): 1689 cm^{-1} (C=O stretching), 1509 cm^{-1} (N=N stretching), 3044 cm^{-1} (aromatic C–H stretching); ^1H NMR (600 MHz, DMSO-d_6): δ 7.45 (d, J = 12.0 Hz, 2H, Ar–H), 7.01 (d, J = 12.0 Hz, 2H, Ar–H), 2.39 (s, 3H, CH_3), 1.92, 1.68, 1.48 (m, 15H, Ad), 1.67 (s, 3H, CH_3); ^{13}C NMR (150 MHz, DMSO-d_6): δ 194.99 (C=O), 148.15 (H_3C–C=C–), 134.50 (Ar–C–N), 133.27 (H_3C–C=C–), 129.71 (Ar–C), 128.96 (Ar–C), 119.21 (Ar–C), 24.10 (H_3C–C=O), 11.13 (CH_3); Anal. Calcd. for $C_{21}H_{25}N_3O$: C, 75.22; H, 7.46; N, 12.54. Found: C, 75.24; H, 7.43; N, 12.55.

Results and Discussion

For the synthesis of the hybrid compound, the derivative 1-[4-(1-adamantylphenyl)]-4-acetyl-5-methyl-1,2,3-triazole (2) was first obtained.

The reaction was carried out in an alkaline medium and proceeded through four stages. In the first stage, the reaction medium was alkalized with a sodium carbonate solution. In the second stage, diazotization was performed at low temperature. In the third stage, p-substituted aryl azide derivatives were prepared using sodium azide (NaN_3). In the final stage, the 1,2,3-triazole derivative (2) was synthesized through a Knoevenagel-type reaction between acetylacetone and p-adamantyl aryl azide catalyzed by potassium carbonate. The reaction proceeded rapidly and afforded the target product in high yield.

Spectroscopic Characterization of the Synthesized Compound (2)

The structures of the synthesized 1,2,3-triazole derivatives (2) were successfully confirmed by FT-IR, ^1H NMR, and ^{13}C NMR spectroscopic analyses.

In compound (2), the characteristic C=O stretching vibrations observed in the FT-IR spectra at approximately 1680–1693 cm^{-1} clearly indicate the presence of the acetyl group, while the absorption bands in the region of 1500–1600 cm^{-1} correspond to N=N stretching vibrations of the triazole ring.

In the ^1H NMR spectra, aromatic protons appear as two doublets (J ≈ 9.6–12.0 Hz), characteristic of para-disubstituted phenyl rings, confirming the structural symmetry of the molecule. Singlet signals observed at approximately δ 2.2–2.7 ppm and δ 1.6–1.7 ppm were assigned to the acetyl and triazole methyl groups, respectively.

In the ^{13}C NMR spectra, signals in the range of δ 189–197 ppm correspond to the carbonyl carbon atom, whereas the remaining aromatic and heterocyclic carbon atoms appear within their expected chemical shift regions.

Conclusion

In this study, 1-[4-(1-adamantylphenyl)]-4-acetyl-5-methyl-1,2,3-triazole (2) was successfully synthesized. The obtained compound may serve as a valuable intermediate for the development of hybrid pharmaceutical agents with enhanced lipophilicity due to the presence of the adamantyl substituent.

References

1. Demirbag B, Yıldırım M, Cimentepe M et al (2025) Salicylaldehydederived hydrazones: synthesis, characterization, antibacterial activity,antioxidant and anti-inflammatory effects on. Biochem Biophys Res Commun 766:151872. https:// doi. org/ 10. 1016/j. bbrc. 2025. 151872

2. Yıldırım M, Unver H, Necip A, Cimentepe M (2025) Design, synthesis,and biological evaluation of

novel vanillin-derived hydrazone compounds with antimicrobial, anticancer, and enzyme inhibition activities, along with molecular structure and drug-likeness assessment. Biochem Biophys Res Commun 775:152173. https:// doi. org/10. 1016/j. bbrc. 2025. 152173

3. Akgul I, Dogan M, Cevik Kuce P et al (2025) Synthesis and biologicalevaluation of P, n-type schiff bases, secondary amines, and thioamide derivatives with molecular docking studies. Chem Biodivers 22:e01330. https:// doi. org/ 10. 1002/ cbdv. 20250 1330

4. Liu XGJTH (2019) Structure – activity study of fluorine or chlorinesubstituted cinnamic acid derivatives with tertiary amine side chain in acetylcholinesterase and butyrylcholinesterase inhibition. Drug Dev Res 80:438–445. https:// doi. org/ 10. 1002/ ddr. 21515

5. Raju R, Chari A, Kotla R et al (2016) Design, synthesis, anticancer, antimicrobial activities and molecular docking studies of theophylline containing acetylenes and theophylline containing 1, 2, 3-triazoles with variant nucleoside derivatives. Eur J Med Chem 123:379–396.https:// doi. org/ 10. 1016/j. ejmech. 2016. 07. 024.

6. Dheer D, Singh V, Shankar R (2017) Medicinal attributes of 1, 2, 3-triazoles: currentdevelopments. Bioorg Chem 71:30–54. https:// doi.org/ 10. 1016/j. bioorg. 2017. 01. 010

7. Esteves PO, Cirne-santos CC, Barros CS et al (2025) Synthesis and evaluation of the activity of 1 H - 1, 2, 3-triazole-thiophene ester derivatives against Chikungunya virus. Microbe. https:// doi.org/10. 1016/j. microb. 2024. 100220.

8. Dharavath R, Nagaraju N, Reddy MR et al (2020) Microwave-assisted synthesis, biological evaluation and molecular docking studies ofnew coumarin-based 1,2,3-triazoles. RSC Adv21:11615–11623. https:// doi. org/ 10. 1039/ d0ra0 1052a.

9. Sumangala V, Poojary B, Chidananda N et al (2010) Synthesis and antimicrobial activity of 1, 2, 3-triazoles containing quinoline moiety. Arch Pharm Res 33:1911–1918. https:// doi. org/ 10.1007/s12272- 010-1204-3.

10. Lu Q, Cui P, Chen Y et al (2020) Nitrogen-containing flavonoid and their analogs with diverse B-ring in acetylcholinesterase and butyrylcholinesterase inhibition. Drug Dev Res 81:1037–1047. https:// doi. org/10. 1002/ ddr. 21726.

11. Haider S, Alam MS, Hamid H (2014) 1, 2, 3-triazoles: scaffold with medicinal significance. Inflamm Cell Signal 1:e95. https:// doi. org/10. 14800/ ics. 95.

EARTH SCIENCES

UDC: 551.577.38

LONG-TERM DROUGHT FORECAST IN UZBEKISTAN BASED ON A DYNAMIC-STOCHASTIC ROOT MODEL

Arushanov M.L.
doctor of geographical sciences, professor
Research Hydrometeorological Institute
Uzbekistan, 100052, Tashkent, Chingiz Aitmatov street, 72
Eshmuratova G.Sh.
Doctoral candidate
Hydrometeorological Research Institute
Uzbekistan, 100052, Tashkent, Chingiz Aitmatov Street, 72
DOI: 10.5281/zenodo.20607031

ДОЛГОСРОЧНЫЙ ПРОГНОЗ ЗАСУШЛИВОСТИ В УЗБЕКИСТАНЕ НА ОСНОВЕ ДИНАМИКО-СТОХАСТИЧЕСКОЙ МОДЕЛИ ХАРАКТЕРИСТИЧЕСКИХ КОРНЕЙ

Арушанов М.Л.
доктор географических наук, профессор
Научно-исследовательский гидрометеорологический институт
Узбекистан, 100052, Ташкент, улица Чингиза Айтматова, 72
Эшмуратова Г. Ш.
Докторант
Научно-исследовательский гидрометеорологический институт
Узбекистан, 100052, Ташкент, улица Чингиза Айтматова, 72

Abstract

The article presents a methodology for long-term forecasting of atmospheric droughts in Uzbekistan with a one-month lead time based on the SPI index. The algorithm is centered on a predictive regression equation constructed using the characteristic roots method. The procedure involves forming an augmented matrix containing columns for both the predictand and predictors, followed by the calculation of a correlation matrix. Predictors include the mean monthly precipitation for each of the three months preceding the forecast, the Southern Oscillation Index (SOI), and Wolf numbers.

Decomposition based on the system of eigenvectors of the correlation matrix ensures high temporal stability of spatial links. This approach allows for the extraction of the most energetically significant oscillations of the climate system while effectively filtering out small-scale noise. The physical advantage of this model over standard regression methods lies in the interpretation of the natural modes (characteristic roots) as reflections of the long-term inertia of moisture transport processes and global teleconnections.

Model verification was conducted using independent data over an 8-year period. The results confirmed the high efficiency of the methodology: the average sign consistency ρ= 0.914, the correlation coefficient R= 0.789, the root mean square error ρ=0.381, and the share of absolute errors exceeding unity $|\Delta_{max}|$>1 averaged 12.8%. Despite a natural decline in accuracy during transitional seasons (March–April, October–November) due to the restructuring of circulation processes and increased frontal activity, the obtained scores remain high for long-term forecasting tasks. Based on these quantitative assessments, the model is recommended for implementation into the operational practice of Uzhydromet and other relevant agencies for drought monitoring and early warning.

Аннотация

В статье представлена методика долгосрочного прогнозирования атмосферных засух в Узбекистане с месячной заблаговременностью на основе индекса *SPI*. Алгоритм базируется на построении прогностического уравнения регрессии через аппарат характеристических корней. Процедура включает формирование расширенной матрицы, содержащей столбцы предиктанта и предикторов, с последующим расчётом корреляционной матрицы. В качестве предикторов использованы средние значения осадков за каждый из трёх месяцев, предшествующих прогнозу, а также индекс Южного колебания (*SOI*) и числа Вольфа за месяц, предшествующий месяцу прогноза.

Разложение по системе собственных векторов корреляционной матрицы обеспечивает высокую временную устойчивость регрессионного уравнения. Это позволяет выделять наиболее энергетически значимые колебания климатической системы, эффективно фильтруя мелкомасштабный шум. Физическое преимущество модели заключается в интерпретации собственных мод как отражения долгосрочной инерции процессов влагопереноса и глобальных телеконнекций.

Верификация модели проводилась на независимом материале за 8-летний период. Результаты подтвердили высокую эффективность методики: средний показатель совпадения знака ρ= 0,914, коэффициент корреляции R=0,789, средняя квадратическая ошибка σ=0,381, а доля максимальных ошибок, превышающих 1, в среднем составила $\left|\Delta_{\max}\right| > 1 = 12{,}8\%$. Несмотря на естественное снижение точности в переходные сезоны (март–апрель, октябрь–ноябрь), обусловленное перестройкой циркуляционных процессов и динамичностью фронтальной деятельности, полученные оценки остаются высокими для задач долгосрочного прогнозирования. На основании количественных показателей модель рекомендована к внедрению в оперативную практику Узгидромета для мониторинга и раннего предупреждения засух.

Keywords: Drought forecasting, *SPI* index, characteristic roots, eigenvectors, Southern Oscillation Index (*SOI*), Wolf numbers, independent verification

Ключевые слова: прогнозирование засухи, индекс SPI, характеристические корни, собственные векторы, индекс Южной осцилляции (*SO*I), число Вольфа, верификация.

Введение

Засуха является одним из наиболее опасных гидрометеорологических явлений, оказывающим деструктивное воздействие на экономику и продовольственную безопасность аридных регионов. Для Узбекистана, где сельское и водное хозяйство критически зависит от режима увлажнения и стока рек, своевременное прогнозирование дефицита осадков является приоритетной государственной задачей. В условиях наблюдающегося глобального изменения климата частота и интенсивность засушливых периодов в Центральной Азии имеют устойчивую тенденцию к росту, что требует совершенствования существующих прогностических схем.

Проблеме оценки и прогнозирования засушливости в регионе посвящено значительное количество исследований. Традиционно для этих целей используются синоптико-статистические методы и анализ региональных атмосферных процессов.

Большой вклад в развитие методов долгосрочного прогнозирования внесли работы узбекских метеорологов, в которых рассматривались связи между крупномасштабной циркуляцией атмосферы и режимом осадков [1,2,4,6].

В последние десятилетия для мониторинга засух широко применяется стандартизированный индекс осадков (*SPI*), рекомендованный ВМО как универсальный инструмент оценки дефицита влаги.

Несмотря на достигнутые успехи, использование классических регрессионных моделей часто сталкивается с проблемой нестабильности прогностических связей во времени и высокой зашумлённости исходных данных. Кроме того, многие современные статистические методы, включая нейронные сети, часто критикуются за отсутствие прозрачной физической интерпретации и невозможность верификации внутренних логических связей модели [11, 14]. Это создаёт проблему «черного ящика», когда высокая точность на обучающей выборке не гарантирует адекватности прогноза при резких изменениях климатической системы [13].

В данной работе предлагается подход, базирующийся на применении динамико-стохастической модели на характеристических корнях. В отличие от стандартной множественной регрессии, данный метод опирается на разложение по системе собственных векторов (ЕОФ) корреляционной матрицы, полученной на основе расширенной матрицы «предиктант – пре- дикторы».

Использование регрессии на главных компонентах [9], равно как и на характеристических корнях [3,5], обеспечивают высокую временную устойчивость регрессионных уравнений и позволяют эффективно фильтровать метеорологический шум, выделяя наиболее энергетически значимые колебания климатической систем. Однако в отличие от традиционного использования главных компонент, подход на основе характеристических корней позволяет учесть внутреннюю инерционность климатической системы и выделить наиболее устойчивые прогностические сигналы индекса *SPI*. Преимущество предлагаемого подхода заключается в возможности интерпретации собственных мод как отражения долгосрочной инерции процессов влагопереноса и глобальных телеконнекций, связывающих региональный индекс *SPI* с индексом Южного колебания (*SOI*) и солнечной активностью (числа Вольфа).

$$Y_i(t_j) = \frac{Z_i(t_j) - \overline{Z_i}}{\sigma_{iZ}},\ X_i(t_j) = \frac{F_i(t_j) - \overline{F_i}}{\sigma_{i_F}},$$

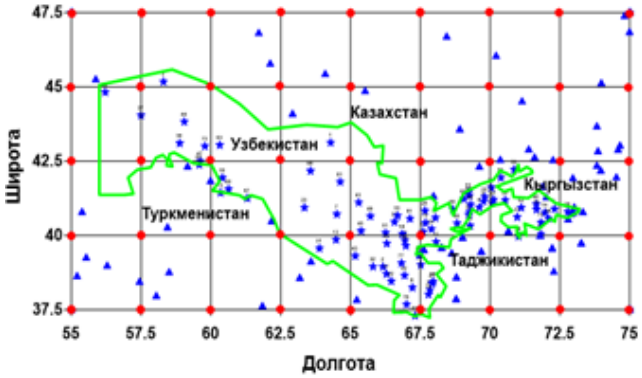


Рис. 1. Метеорологическая сеть Узгидрометa (★) и сопредельных стран (▲), узлы регулярной сетки реанализов (●).

Цель исследования. Разработать методику долгосрочного прогнозирования засушливости в Узбекистане с месячной заблаговременностью на основе разложения по системе естественных ортогональных функций и анализа характеристических корней динамико-стохастической модели.

Объект исследования. Пространственно-временная динамика индекса засушливости *SPI* на территории Узбекистана**.**

Данные и методы расчёта. В качестве анализируемых метеовеличин рассматривались данные наблюдений о температуре воздуха, осадках, влажности воздуха по данным метеорологической сети Узгидромета (рис. 1) за имеющейся на той или иной метеорологической станции период наблюдений. По этим данным были получены среднемесячные значения за каждый месяц года. Тот же набор метеорологических величин использован в виде реанализов NCEP/NCAR [10] среднемесячных значений в узлах регулярной сетки 2,5×2,5° за период с 1948 по 2022 гг.

Временные ряды указанных выше метеорологических величин организованы в виде базы данных (рис. 2), в которую помимо метеорологических величин, включены вариации солнечной активности (числа Вольфа), индекс Южной осцилляции *SOI*, за соответствующий период (1948-2022 гг.). Временные ряды предикторов $F_i(t_j)$, i = 1,2,…,5, j = 1, 2,…, N и предиктанта $Z_i(t_j)$ стандартизируются:

где

$$\sigma_{iF} = \sqrt{\frac{1}{N}\sum_{j=1}^{N}\left(F_i(t_j)-\overline{F_i}\right)^2},$$

$$\sigma_{iZ} = \sqrt{\frac{1}{N}\sum_{j=1}^{N}\left(Z_i(t_j)-\overline{Z_i}\right)^2}$$

– средние квадратичные отклонения.

Далее строится расширенная матрица **A** размером $N\times(i+1)$:

$$A=(Y,X)=\begin{pmatrix} Y_{11} & X_{11} & X_{21} & \dots & X_{i1} \\ Y_{12} & X_{12} & X_{22} & \dots & X_{i2} \\ \vdots & \vdots & \vdots & & \vdots \\ Y_{1N} & X_{1N} & X_{2N} & \dots & X_{iN} \end{pmatrix}$$

и симметричная корреляционная матрица: $\mathbf{R} = (\mathbf{A}^{\mathrm{T}}\mathbf{A})^{-1}$ размером $(i+1)\times(i+1)$.

$$\boldsymbol{R}=\begin{pmatrix} 1 & R_{21} & \dots & R_{i1} \\ & R_{22} & \dots & R_{i2} \\ & 1 & \dots & R_{i3} \\ & & 1 & \dots \\ & & & 1 \end{pmatrix}$$

Следующий шаг – вычисление собственных чисел λ_m и собственных векторов φ_{jm} корреляционной матрицы.

Оценки коэффициентов регрессии a_j находятся по формуле

$$a_j = -\frac{c\sum_{m=1}^{k}\varphi_{om}\varphi_{jm}}{\lambda_m}, \quad j=1,2,\dots,k, \quad (1)$$

где φ_{om} – 1-ый собственный вектор, φ_{jm} – последующие собственные векторы, расположенные в порядке убывания собственных чисел, а c определяется из выражения

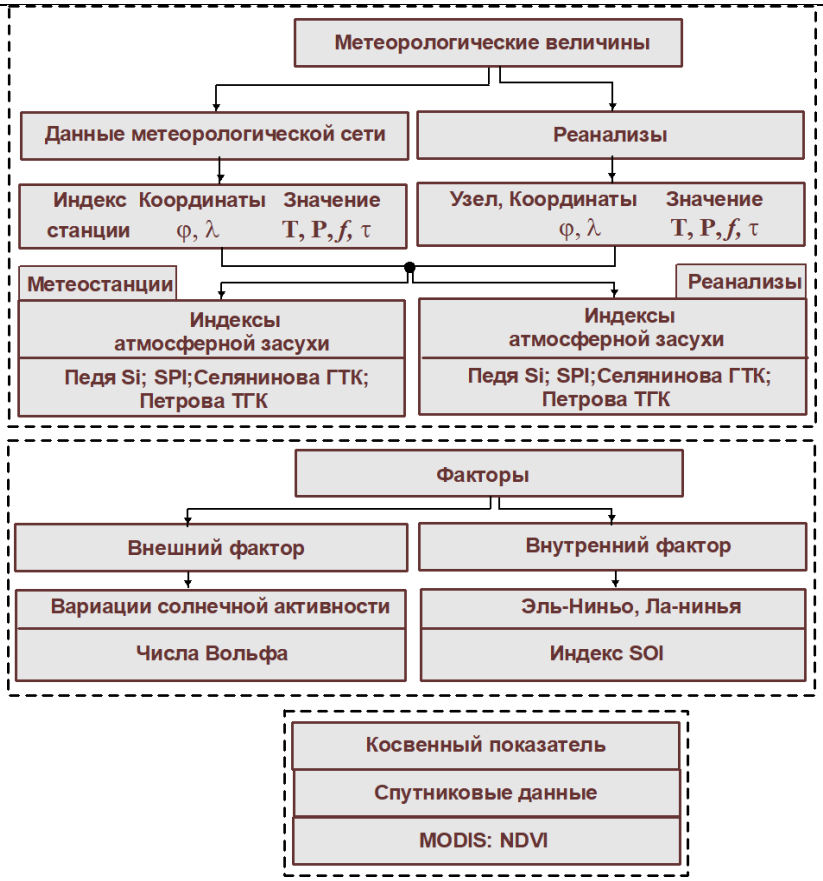


Рис. 2. Структура базы данных.

Примечание: T – температура ºC, *P* – осадки мм, *f* % – относительна влажность, □□– точка росы ºC. ТГК – термогигрометрический коэффициент сухости %o; *SOI* – индекс Южной осцилляции; ГТК – гидротермический коэффициент; *NDVI* – нормализованный вегетативный индекс.

$$c = \left(\sum_{m=1}^{k} \left(\varphi_{om}^2 \right) / \lambda_m \right)^{-1} \times \sigma_z$$

Остаточная сумма квадратов определяется по формуле

$$Q_{ост} = \sigma_z^2 \left(\sum_{m=1}^{k} \left(\varphi_{om}^2 \right) / \lambda_m \right)^{-1} = c\sigma_z .$$

Численные эксперименты. Верификация модели.

Численные эксперименты прогноза метеорологической засухи с месячной заблаговременностью с использованием подготовленной базы данных (рис. 2), составляющими которой являются предикторы: среднемесячные осадки, индекс Южного колебания, числа Вольфа и предиктант – рассчитанные значения индекса засушливости *SPI*. Период обучающей выборки составил 50 лет (1966-2015), а независимой – 8 лет (2016-2023). Прогноз рассчитывался для 12 областных центров Узбекистана и г. Ташкента.

В качестве количественных оценок точности прогноза приняты:

среднеквадратичная ошибка

$$\sigma_{пр} = \frac{1}{N} \sum_{i=1}^{N} \left(SPI_{фак} - SPI_{пр} \right)^2 ;$$

максимальная абсолютная ошибка

$$\Delta_{max} = max \left| SPI_{фак} - SPI_{пр} \right| ;$$

коэффициент корреляции

$$R_{фп} = \frac{\sum_{i=1}^{N} \left(SPI_{фак} - \overline{SPI}_{фак} \right) \left(SPI_{пр} - \overline{SPI}_{пр} \right)}{\sqrt{\sum_{i=1}^{N} \left(SPI_{фак} - \overline{SPI}_{фак} \right)^2 \sum_{i=1}^{N} \left(SPI_{пр} - \overline{SPI}_{пр} \right)^2}} ;$$

совпадение по знаку

$$\rho = \frac{n_+ - n_-}{n},$$

где $SPI_{фак}$ – фактическое значение индекса засушливости; $SPI_{пр}$ – прогностическое значение индекса засушливости, n+ – число значений *SPI* с совпавшими знаками, n–с не совпавшими знаками, n – общее количество случаев.

Таким образом, математическая обоснованность оценки точности модели прогноза SPI обеспечивается применением взаимодополняющего набора количественных параметров: среднеквадратической ошибкой σ – определяет ам-плитудную точность; коэффициентом корреляции *R* – характеризует фазовую синхронность; параметром ρ – количественной мерой точности попадания в целевой

сектор градаций; максимальной ошибкой и процентом её превышения 1.

При анализе перечисленных параметров оценок точности прогноза необходимо учитывать масштаб индекса SPI, измеряемого в стандартных отклонениях (как правило, от -3 до +3). Тогда доля абсолютной ошибки в 0.5 единиц составляет небольшую часть рабочего диапазона индекса и при $\sigma = 0.5$ модель с большой вероятностью правильно определяет категорию состояния увлажнённости (засушливости).

Общая картина точности модели сведена в сводную таблицу (табл. 1), в которой приведены указанные параметры точности модели, осреднённые за 8 лет по результатам прогноза *SPI* путём осреднения каждого из показателей точности прогноза по 12 административным пунктам Узбекистана и г. Ташкенту для каждого месяца года.

Средний по всей выборки выполненных прогнозов коэффициент корреляции указывает на полную адекватность модели. Совокупностью включённых в расширенную матрицу предикторов (осадки за предшествующий трёхмесячный период, индекс Южного колебания и числа Вольфа за предшествующий месяц) описывается 62,3% общей дисперсии прогнозируемой величины ( ).

Распределение долей между предикторами зависит от времени года и в среднем составляет: вклад осадков за предшествующие 3 месяца σ_{oc} = 45% – средние за каждый из 3-х месяцев осадки формирует «базис» увлажнения; вклад индекса Южного колебания *SOI* составляет σ_{SOI} = 10% – влияет на сдвиг амплитуды отклонений; вклад чисел Воль-фа (вариаций солнечной активности) наименьший, но статистически значимый, составляет σ_W = 7%.

Наиболее высокая точность прогноза *SPI* в зимние и летние периоды года. Разница в точности прогноза *SPI* для Узбекистана между «стабильными» (зима, лето) и «переходными» (весна, осень) сезонами объясняется сменой механизмов влагопереноса и физикой атмосферных процессов.

В зимний период основная влага поступает с Атлантики и Средиземноморья. Траектории этих воздушных течений жёстко связаны с глобальным индексом Южного колебания (*SOI*). Кроме того, зимние осадки формируются устойчивыми фронтальными системами. Если предшествующие 3 месяца были влажными, это часто указывает на активную фазу западного переноса, которая имеет тенденцию сохраняться [2,6].

Вариации солнечной активности (числа Вольфа) в зимний период играют роль «дирижёра» планетарного масштаба, который определяет, по какому сценарию пойдёт распределение осадков в Центральной Азии. Для Узбекистана в зимние месяцы этот фактор работает через три основных физических механизма: модуляцию Сибирского антициклона, смещение субтропического струйного течения и влияние на стратосферные потепления. Эти механизмы подробно исследованы российскими учёными В. Ф. Логиновым [7], Н. В. Кобышевой [8] и китайскими учёными Х. Ма (H. Ma), Д. Чен (J. Chen) [12].

Высокие оценки точности прогноза SPI в летний период определяются стабильной термической депрессией и практически полным отсутствием осадков. Хотя летом осадков мало, модель крайне точно предсказывает сохранение засушливых условий. Это видно по низким значениям и среднему за летний период (июнь, июль, август) значению параметра ρ = 0,961, что критически важно для мониторинга экстремальных засух.

Таблица 1

Средние по 13 пунктам Узбекистана оценки модели прогноза *SPI* по выборке за 8 лет (общее число прогнозов 13×12×8=1248)

Месяц прогноза	$\lvert\Delta_{max}\rvert$	$\lvert\Delta_{max}\rvert$ >1, %	□	$R_{фп}$	□пр	Градации □пр	Характеристика успешности
Январь	1.132	6. 7	1.000	0.857	0.290	**< 0.3**	Исключительная точность
Февраль	1.123	4.8	1.000	0.818	0.235		
Март	1.398	28.8	0,903	0.758	0.391		
Апрель	1.321	26.0	0.855	0.766	0.440	**0.3–0.6**	Высокая точность
Май	1.282	13.5	0.884	0.732	0.447		
Июнь	0.972	4.8	0.894	0.853	0.388		
Июль	0.922	2.9	1.000	0.898	0.324		
Август	0.898	12.5	1.000	0.869	0.307	**0.7–1.0**	Умеренная точность
Сентябрь	0.890	2.46	0.884	0.736	0.462		
Октябрь	1.101	14.4	0.884	0.629	0.496	**>1**	Низкая точность
Ноябрь	1.284	27.8	0.798	0.707	0.568		
Декабрь	1.043	6.7	0.875	0.854	0.324		
Среднее	**1,113**	**12.8**	**0,914**	**0,789**	**0,381**		

В осенне-весенний период (март, апрель, ноябрь) – переходные периоды, точность модели падает (> 1 в 26–28.8%). Это периоды перестройки атмосферной циркуляции. Высокая доля ошибок связана с локальными конвективными процессами и резкой сменой фаз увлажнения. Иначе говоря, усиление нелинейности атмосферных процессов в переходные периоды является фундаментальной причиной изменения точности модели: весной (март-апрель) и осенью (ноябрь) термодинамическое состояние атмосферы в Центральной Азии становится крайне неустойчивым, характеризуемое

переходом от радиационного выхолаживания к инсоляционному прогреву (и наоборот). Связи между глобальными предикторами (*SOI*, числа Воль-фа) и локальными осадками становятся сильно нелинейными, например, одно и то же значение *SOI* может привести к разным результатам в зависимости от локальной термической конвекции. Тем не менее, если классическая линейная регрессионная модель в такие периоды, как правило, «разваливается», модель на собственных числах работает иначе, хотя формально уравнение регрессии выглядит линейным

$$SPI(\mathrm{t}) = a_o + \sum_{i=1}^{3} B_i X(t-1) + B_i X(t-2) + \\ + B_i X(t-3) + \sum_{i=4}^{5} B_i X_i(t-1),$$

где $B_i = \sum_{i=1}^{k} a_j \varphi_{ij}$, а коэффициенты регрессии a_j определены согласно (1).

Собственные числа λ_i извлекают информацию о внутренней структуре всей системы взаимодействующих факторов в целом, описывая вариацию системы, а не просто сумму переменных. Использование характеристических корней позволяет учитывать синергетические эффекты (взаимовлияние осадков, солнечной активности и океанических индексов). Это даёт модели, в отличие от классической регрессионной, ту самую «гибкость», которая позволяет ей удерживать ρ на уровне 0.8–0.9 даже при росте абсолютных ошибок.

Выводы

На основе представленных оценок точности и физического анализа модели на характеристических корнях долгосрочного прогноза *SPI*, можно сформулировать следующий общий вывод: разработанная прогностическая модель индекса *SPI* с заблаговременностью 1 месяц показывает высокую диагностическую и прогностическую эффективность, превосходящую стандартные методы линейной регрессии. Использование аппарата характеристических корней позволило успешно интегрировать инерционность локальных осадков с глобальными предикторами (*SOI* и числами Вольфа). Средний коэффициент корреляции R = 0.79 и низкая среднеквадратичная ошибка σ = 0.38 свидетельствуют о том, что модель объясняет более 60% дисперсии индекса *SPI*, а среднее значение параметра ρ = 0.914 является критически важным – в 91% случаев модель безошибочно определяет засушливый (влажный) характер прогнозируемого месяца. Метод собственных чисел успешно справляется с нелинейностью климатических связей, особенно в переходные сезоны. Несмотря на естественный рост максимальных ошибок $|\Delta \max| > 1$ в марте и ноябре до 26-28%, модель сохраняет устойчивость, не допуская «развала» прогноза, что характерно для обычных моделей метода наименьших квадратов.

Модель на характеристических корнях является репрезентативной и физически обоснованной. Она успешно решает проблему мультиколлинеарности предикторов и эффективно выделяет значимый сигнал из зашумлён-ных данных солнечной и атмосферной активности. Сказанное подтверждает иллюстративный рисунок фактического и прогностического распределения *SPI* для центральных месяцев сезона года (рис. 3).

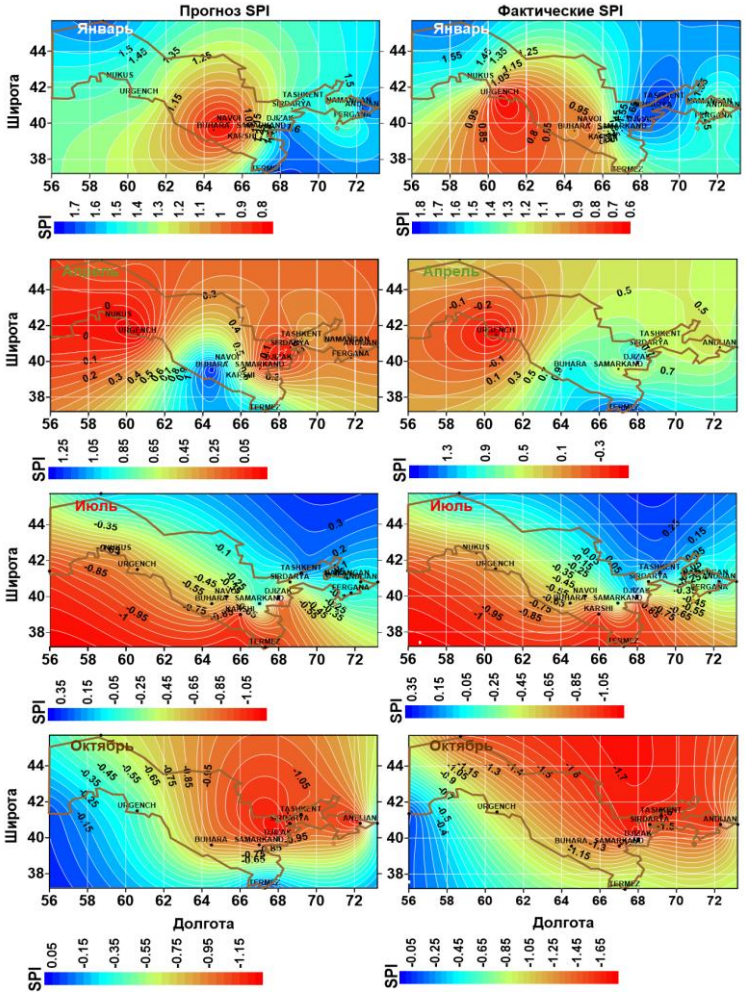


Рис. 3. Прогностические и фактические поля SPI для центральных месяцев 2020 года.

References

1. Buga, O. P. Methodology for Long-Term Precipitation Forecasting in Central Asia // Proceedings of SANIGMI, 1985, pp. 24–33.
2. Bugayev, V. A., Giorgio, V. A., Kozik, E. M., et al. “Synoptic Processes of Central Asia,” Tashkent: Academy of Sciences of the Uzbek SSR, V. I. Romanovsky Institute of Mathematics and Mechanics, 1957, 477 p.
3. Vechkov, I., Boyadzhieva, L., Solakov, E. “Applied Linear Regression Analysis,” Moscow: Finance and Statistics, 1987, 238 p.
4. Gruza, G. V. “Statistical Methods for Forecasting Meteorological Fields,” Leningrad: Hydrometeoizdat, 1971, 206 p.
5. Draper, N., Smith, S. Applied Regression Analysis. Moscow: Finance and Statistics, 1986, 365 p.
6. Inagamova, S. I., Mukhtarov, T. M., Mukhtarov, Sh. T. Features of Synoptic Processes in Central Asia. Tashkent: SARNIGMI, 2002, 485 p.
7. Kobysheva, N. V., and A. S. Kudryavtseva. Variability of the Siberian Anticyclone in Connection with Solar Activity // Proceedings of the A. I. Voeikov Main Geophysical Observatory, issue 565, 2012, pp. 136–148.
8. Loginov, V. F. Solar Indices and Climate. Leningrad: Gidrometeoizdat, 1984, 412 p.
9. Meshcherskaya A. V., Rukhovets L. V., Yudin M. I., Yakovleva I. I. Natural Components of Meteorological Fields. Leningrad: Gidrometeoizdat, 1970. 200 p.
10. NCEP/NCAR Reanalyses – Electronic resource: https://reanalyses.org/atmosphere/ comparison-table Reanalysis
11. Hsieh W. W. Machine Learning Methods in the Environmental Sciences: Neural Networks and Kernels. Cambridge University Press, 2009, pp. 315–320.
12. Ma H., Chen J., Solar cycle modulation of the connection between the North Pacific Oscillation and the following winter's Siberian High // Journal of Geophysical Research: Atmospheres. Vol. 119, Iss. 17. – 2014. – P. 10,211–10,224. – DOI: 10.1002/2014JD021650.
13. McGovern A. et al. Making the Black Box Transparent: Integrated AI and Predictive Analytics in Weather Forecasting // Bulletin of the American Meteorological Society. Vol. 100(12).– 2019. – P. 2475-2492.
14. Roscher R., Bohn B., Duarte M. F., Garcke J. Explainable Machine Learning for Scientific Insights and Predictions // IEEE Access. Vol. 8. – 2020. – P. 101600-101610.

ECONOMIC SCIENCES

ACTIVATION OF TRADE RELATIONS AND GEORGIA'S STRATEGIC ROLE IN CARGO TRANSPORTATION THROUGH THE MIDDLE CORRIDOR

David Bidzinashvili
Doctor of Economics, Professor Gori State University, Georgia
https://orcid.org/0000-0002-2311-4110
Tea Khorguashvili
Doctor of Economics, Professor Gori State University, Georgia
DOI: 10.5281/zenodo.20607104

Abstract

The ongoing military operations in Iran and the Middle East have further highlighted Georgia's strategic role. Due to the closure of the Strait of Hormuz, the importance of the Middle Corridor as the safest and most strategic alternative for cargo transportation has come to the forefront of the international agenda. Georgia, in turn, is one of the key countries within the Middle Corridor.

It is in this context that we should consider the fact that, for the first time in the history of independent Georgia, Georgian Railway is launching a large-scale modernization of its rolling stock. As part of the project, the company plans to acquire up to 50 locomotives and 1,500 railcars, and procurement procedures have already begun.

It is evident that for Georgia, as a country with strong transit ambitions, the development of infrastructure — especially port infrastructure — is critically important for utilizing these new opportunities.

Keywords: Middle Corridor; Strait of Hormuz; Cargo Transportation; Cargo Flow; Infrastructure; Export Potential; Trade Relations.

Intraduction: The role of the Middle Corridor is growing. Recently, the closure of the Strait of Hormuz has had a significant impact in this regard, creating yet another opportunity for our country to handle increased cargo flows. A certain portion of cargo has already started moving toward Georgia, which has raised considerable expectations among some experts, while others remain somewhat skeptical, believing that the state lacks both the infrastructure and the human resources necessary to respond effectively to this challenge.

Reserchobjective: The aim of the presented study is to examine the opportunities available to Georgia as a country with transit ambitions, assess the existing challenges, and develop relevant recommendations; to explore alternative routes for cargo transportation in light of the closure of the Strait of Hormuz; and to identify the characteristics of the existing infrastructure as well as the possibilities for its improvement.

Methology: The theoretical and methodological foundation of the study is based on the research and scientific publications of Georgian and foreign scholars, as well as data from the National Bank of Georgia, the Ministry of Finance of Georgia, the National Statistics Office of Georgia, and social policy documents. An in-depth analysis of the existing data was conducted, and a number of conclusions and recommendations were developed.

Review and discussion: As you know, due to the Russia–Ukraine war and global crises in general, established and traditional routes have been disrupted. Consequently, the countries of Central Asia have faced the challenge of finding alternative transport routes. The main cargo flows from Central Asia to Europe were transported through the Northern Corridor, via Russian territory. Although the route was long, it was one of the most tested and traditional transit corridors. However, as international sanctions were imposed, the Northern Corridor was effectively closed, creating a serious challenge for all the countries that relied on this route — particularly the countries of Central Asia. In reality, the main alternative route has become Georgia and the Middle Corridor.[1]

The Russian corridor was long, but it operated under a single tariff system. The challenge of the Middle Corridor, however, lies in its multimodal nature, as it passes through several countries. Since February of this year, another issue has been added to these challenges — the problem of the Strait of Hormuz. Both the Northern Corridor and the Strait of Hormuz create supply shocks. This affects not only the region itself, but also the region's trading partner countries. Therefore, when we say that Georgia's role has already increased and will continue to grow, this is exactly what we mean. Its importance will grow precisely because, despite being a multimodal platform, it represents the shortest route available.[2]

This policy is also reflected in the fact that Georgia has launched the accelerated construction of the Anaklia project, as the Anaklia port is, in itself, one of the most important infrastructures of the Middle Corridor. Anaklia Deep Sea Port. [3]

The first phase of the Anaklia project was completed by a Dutch company, and the second phase of deepening is now underway, with the Government of Georgia actively involved. In this case, this includes the improvement of road infrastructure leading to the port. Anaklia Deep Sea Port is a response to increased cargo turnover as one of the key infrastructures of the Middle Corridor. It addresses the global challenges we face today and is not merely a purely economic factor. Rather, it is a geo-economic project for the coming years and possibly decades. One indication and signal of this is also the interest shown by Turkmenistan. [4]

In the future, we will see how the load and the role of the Middle Corridor will further increase. That is why we say that the Anaklia project represents one of the promising outlooks for the future, which the country indeed has—provided that it maintains stability in the years to come.

Conclusion and Recommendations: Turkmen Railways is an important partner for our country. This year we have achieved quite good results—the cargo turnover dynamics are growing. We believe there is potential to further improve this indicator. We expect that in the current year, the volume of cargo turnover with Turkmenistan will increase significantly.

The Central Asian countries have strong export potential, and their main partners are Russia and China. If they decide to redirect their cargo flows toward the West as well, then, of course, we must be prepared in this regard. When speaking about Central Asian countries, we have long-standing cooperation with Kazakhstan. China is, in itself, one of our key targets, so that Chinese cargo can move through our corridor toward the West.

As for other countries, they should also ensure that cargo is redirected to the Middle Corridor. Everything depends on trade relations and the potential of these countries.

In this regard, the readiness of our transit corridor is crucial, both in rail, road, and maritime directions. Above all, peace in the region is essential, because the reasons for the blocking or restriction of alternative routes are, fundamentally, war and conflict. There is war in Russia–Ukraine as well as in Iran and the Middle East. Therefore, stability in the South Caucasus and across the entire Middle Corridor route is extremely important.

References

1. https://www.gov.ge/index.php?lang_id=GEO&sec_id=602&info_id=88898

2. https://www.economy.ge/?page=economy&s=149&lang=ge

3. Riina Palu & Olli-Pekka Hilmola - “Future Potential of Trans-Caspian Corridor:Review”, *Logistics* (MDPI), 2023. https://doi.org/10.3390/logistics7030039

4. Adilbek Yermekbayev, Leila Delovarova & Aliya Kaliyeva - “Trans-Caspian International Transport Route: A Kazakhstani Perspective on Challenges, Opportunities, and Prospects”, *International Journal* (SAGE), 2024. https://doi.org/10.1177/0020702024125763

PERCEPTIONS AND ADOPTION BARRIERS OF AI IN ACCOUNTING FIRMS: RESEARCH ON KAZAKHSTAN VS. GLOBAL RESULTS

Uakhit Kamila Asankyzy
Narxoz University, Corporate Governance, Compliance and Performance Appraisal (НПМ) Kazakhstan, Almaty
DOI: 10.5281/zenodo.20607253

Abstract

The integration of Artificial Intelligence (AI) into accounting is reshaping the profession, improving automation, decision-making, and analytical capabilities. Yet, the adoption of AI varies greatly across countries, influenced by local infrastructure, education, and organizational culture. This study examines the perceptions and barriers surrounding AI adoption in accounting firms, comparing Kazakhstan's experience with global practices. Drawing from academic and industry sources, the research identifies key challenges such as limited technical expertise, resistance to change, high implementation costs, and regulatory uncertainty. The findings emphasize the need for targeted education, policy support, and innovation-driven strategies to enhance Kazakhstan's competitiveness in the global accounting landscape.

Keywords: Artificial Intelligence, Accounting, Kazakhstan, Perception, Barriers, Digital Transformation, Automation

Introduction

Artificial Intelligence (AI) technologies—such as machine learning, robotic process automation (RPA), and natural language processing—are transforming accounting practices worldwide. AI enables firms to automate repetitive tasks, detect anomalies in real time, and generate predictive insights for strategic decisions (Sutton, Holt & Arnold, 2020). Globally, AI adoption has expanded rapidly, with firms like Deloitte, KPMG, PwC, and EY embedding AI tools in auditing, taxation, and financial reporting (PwC, 2023).

However, in emerging economies such as Kazakhstan, AI integration remains limited. Despite the national "Digital Kazakhstan" initiative launched in 2018 to promote digital transformation, the accounting industry still relies heavily on manual operations and traditional data systems (Ministry of Digital Development, 2022). This lag can be attributed to limited digital skills, insufficient investment, and unclear regulatory guidance.

This paper explores how accountants in Kazakhstan perceive AI technologies and what barriers hinder their adoption, comparing these findings to global trends. Understanding these differences is essential for designing effective strategies to enhance digital innovation within Kazakhstan's accounting sector.

Global Overview of AI in Accounting

In developed economies, AI technologies are deeply embedded within accounting operations. AI-driven software performs complex audits, identifies irregularities, and supports decision-making with predictive analytics (Deloitte, 2020). For example, **KPMG's Clara** platform automates data analysis during audits, while **EY Helix** applies AI to identify fraud patterns across transactions (KPMG, 2021; EY, 2023).

Regulatory and institutional support further facilitates AI adoption. In the United States and the United Kingdom, accounting firms operate under data protection laws—such as GDPR and CCPA—that foster trust in digital technologies. Moreover, ongoing collaboration between government, academia, and professional bodies ensures that accountants receive continuous training in digital tools (ACCA, 2023).

China's experience also demonstrates rapid AI adoption, driven by government-backed FinTech initiatives and strong domestic demand for automation (OECD, 2022). Accounting systems in major Chinese firms now integrate AI for tax processing, compliance monitoring, and risk forecasting.

Overall, developed economies display high digital readiness, well-trained professionals, and established policies that enable AI-driven transformation in accounting.

AI Adoption and Perceptions in Kazakhstan

Kazakhstan's accounting sector is at an early stage of AI adoption. While large multinational firms operating in the country—such as the Big Four—employ AI solutions for automation and data management, most local firms continue to depend on manual or semi-automated processes (EY Kazakhstan, 2023).

1. Awareness and Perception

A 2021 ACCA survey revealed that only 18% of accountants in Kazakhstan had practical experience using AI tools (ACCA, 2021). Many practitioners perceive AI as a potential threat to job security, fearing automation could replace traditional accounting roles. Others express skepticism about the reliability of AI-generated outputs, preferring human judgment.

2. Educational and Skill Gaps

AI-related education within accounting programs remains limited. Although universities in Kazakhstan are gradually introducing courses on data analytics, machine learning, and digital finance, these initiatives are insufficient to meet market demand (Ministry of Science and Education, 2023).

3. Regulatory and Institutional Context

Kazakhstan lacks a comprehensive legal framework for AI in accounting. Existing laws cover electronic documentation and digital signatures but do not address algorithmic accountability or data ethics (National Bank of Kazakhstan, 2023). This uncertainty discourages firms from investing in AI systems.

Comparative Analysis

Table 1

Summarizes the comparative metrics between Kazakhstan and global accounting leaders regarding AI adoption and perception.

Metric	Kazakhstan	Global (US/UK/China)
Awareness of AI tools	Moderate	High
Workforce AI skills	Low	High
Automation in accounting	Partial (large firms only)	Advanced (most sectors)
Predictive analytics	Rare	Common
Regulatory support	Limited	Strong
Job security concerns	High	Moderate

As shown, Kazakhstan trails significantly behind global peers across nearly all categories. Developed nations view AI as a tool that enhances professional value, whereas in Kazakhstan, many accountants still perceive it as a threat to employment.

Graph 1. AI Adoption in Accounting (% of firms using AI tools)

(Illustrative academic figure: Kazakhstan ~20%, USA ~85%, UK ~80%, China ~70%)

Key Barriers to AI Adoption in Kazakhstan

AI adoption in Kazakhstan's accounting sector faces multiple systemic challenges:

- **Lack of Technical Expertise:** Most accountants lack formal training in AI and data analytics, making it difficult to integrate digital tools.
- **High Implementation Costs:** Advanced AI platforms are financially inaccessible to small and medium-sized firms.
- **Regulatory Uncertainty:** Absence of clear guidelines on AI use, data protection, and auditing standards creates compliance risks.
- **Cultural Resistance:** Accounting professionals often value manual verification and may distrust automated systems.
- **Limited Infrastructure:** Despite improvements under the Digital Kazakhstan program, disparities in internet connectivity and technology adoption persist between regions.

Pie Chart 1. Key Barriers to AI Adoption in Kazakhstan

(Example data visualization: Skills gap 30%, Cost 25%, Regulation 20%, Infrastructure 15%, Cultural resistance 10%)

Opportunities and Policy Recommendations

Despite existing barriers, Kazakhstan holds strong potential to advance AI adoption in accounting through targeted strategies:

1. **Educational Reform:** Universities and professional associations should integrate AI, data analytics, and digital finance into accounting curricula and certifications.
2. **Government Support:** Tax incentives and funding for AI adoption among SMEs can encourage wider implementation.
3. **International Collaboration:** Partnerships with global firms and foreign universities can transfer expertise and technologies.
4. **Regulatory Development:** Establishing clear AI governance frameworks would reduce legal uncertainty and promote innovation.
5. **Cultural Change:** Promoting success stories and professional workshops can shift perceptions of AI from threat to opportunity.

Such initiatives would accelerate Kazakhstan's transition toward a data-driven accounting environment aligned with international standards.

Conclusion

Artificial Intelligence is redefining the global accounting profession by automating processes, enhancing accuracy, and enabling strategic insights. While developed economies have fully integrated AI into accounting systems, Kazakhstan remains at the preliminary stage of adoption.

This study reveals that Kazakh accountants generally perceive AI with caution due to skill shortages, regulatory ambiguity, and cultural resistance. However, with strategic reforms in education, regulation, and investment, Kazakhstan has the potential to close the digital gap and position its accounting profession for the future.

By fostering collaboration between government, academia, and industry, Kazakhstan can build a robust ecosystem where AI supports—not replaces—the human expertise central to accounting integrity.

References

1. ACCA. (2021). *The Future of Accounting and AI in Central Asia.* Retrieved from www.accaglobal.com
2. Deloitte. (2020). *AI and the Future of Financial Services.* Retrieved from www.deloitte.com
3. EY Kazakhstan. (2023). *Audit Innovation and AI Tools.* Retrieved from www.ey.com/kz
4. KPMG. (2021). *KPMG Clara: Smart Audit Platform.* Retrieved from home.kpmg
5. Ministry of Digital Development of Kazakhstan. (2022). *Digital Kazakhstan: Annual Report.* Retrieved from www.digital.gov.kz
6. Ministry of Science and Education. (2023). *Higher Education Modernization Report.* Retrieved from www.edu.gov.kz
7. National Bank of Kazakhstan. (2023). *Annual Report on Financial Technologies.* Retrieved from www.nationalbank.kz
8. OECD. (2022). *Digital Economy Outlook.* Retrieved from www.oecd.org
9. PwC. (2023). *AI Adoption in Accounting: Global Survey.* Retrieved from www.pwc.com
10. Sutton, S. G., Holt, M., & Arnold, V. (2020). *Artificial Intelligence in Accounting: Current Developments and Future Directions.* International Journal of Accounting Information Systems, 36, 100541.

DIGITAL MARKETING TRANSFORMATION IN THE HOTEL BUSINESS AND ITS MODERN TRENDS IN GEORGIA

Natia Zhozhuashvili
Associate Professor, Doctor of Economics,
Gori State University. Head of the Bachelor of Business Administration Program
Nino Orjonikidze
Professor, Doctor of Economics, Gori State University.
Head of Quality Assurance Service
DOI: 10.5281/zenodo.20607298

Abstract

The modern hotel business is developing against the background of rapid progress (improvement) of digital technologies. Digital resources have a significant impact on practically all operational directions of the hospitality sector. Marketing strategies of hotels in the tourism sector are changing significantly, which is due to changes in consumer behavior, the increased role of digital communication channels, and the multifaceted processes taking place in the platform economy. Under these conditions, traditional methods of service promotion are gradually being replaced by data-based analysis and personalized digital approaches tailored to the individual needs of the user.

This paper examines the main stages of marketing transformation against the background of the development of digital technologies for the hotel business, using the example of a country with a developing economy, Georgia. The paper analyzes changes in marketing communication channels, online distribution, pricing systems, and customer engagement mechanisms. Special attention is paid to the role of digital platforms, big data technologies, and artificial intelligence in improving the effectiveness of marketing activities of hotel companies. The empirical base includes statistical data from the Georgian national tourism administration (GNTA), the world bank (WB), and international analytical agencies (Unwto, Statista, OTA, etc.) for 2023–2025. The results of the study show that digitalization is a key factor in increasing the competitiveness of hotel chains, providing personalized service, increasing marketing efficiency, and improving customer experience. In addition, the study reveals a number of important challenges that accompany the digital transformation of the Georgian hotel industry. These include the uneven level of implementation of digital technologies in small and medium-sized hotels, limited financial and technological resources, a shortage of qualified digital skills, and insufficient integration of data management systems. The high level of dependence on online platforms also remains a problem, which reduces direct sales opportunities and increases the share of intermediary costs. Additionally, the protection of users' personal data and cybersecurity issues are becoming increasingly pressing challenges.

Thus, despite digital transformation's positive influence, its effective implementation in Georgia, as in other developing economies, requires a systemic approach, technological investments implementation, and human resources development, which finally determines industry long-term competitiveness.

Keywords: Digital transformation, hotel industry, digital marketing, hospitality management, customer experience.

Introduction

The current stage of development of the global hotel industry is characterized by a deep digital transformation that encompasses all elements of marketing activities. Digital technologies are radically changing the way hotels interact with customers, their sales channels, and advertising tools.

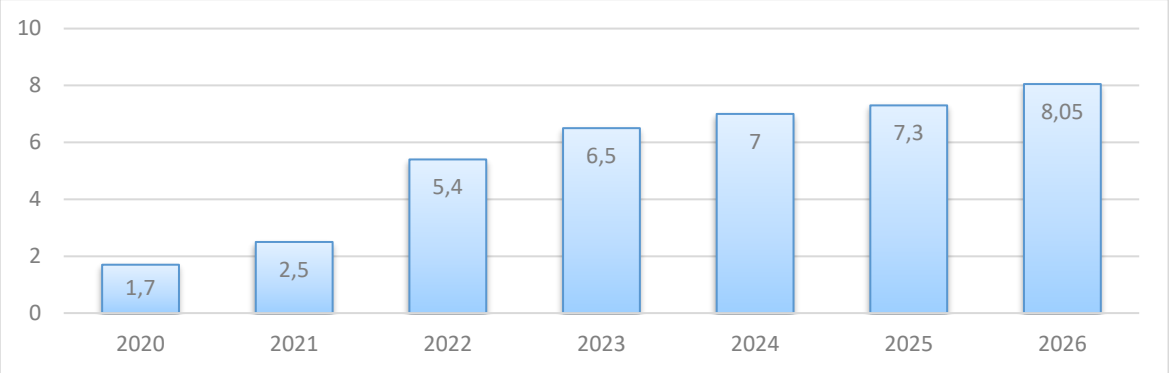
This issue is especially relevant for countries with a developing tourism sector, such as Georgia. Georgia stands out unique natural with diversity , which combines black sea coast, Caucasus in the mountains and rich landscapes , which the country all four in season attractive tourist direction makes. In terms of cultural Georgia, one of the ancient civilizations, it is a place where historical monuments, traditions, and wine production, millennial culture, and special interest causes. Country hospitality and national kitchen also play an important role in attracting tourists to attractions. In this in process important function performed by the Georgian National Tourism Administration, which actively carries out country popularization international at the markets and hand it helps tourism sector development . In recent years, Georgia has shown a steady and significant increase in tourist flows: according to the National Tourism Administration, a record number of tourists was recorded in 2024. Georgia was visited by 7.36 million international visitors, [1]which is a 4.2% increase compared to 2023, and compared to 2019, this figure reflects a significant increase 78.7%. Of these, 5.1 million tourists entered the country, which significantly exceeds the pre-crisis level and represents a 9% increase compared to the previous year, although compared to 2019, the number of tourist visits increased slightly, by 0.2%. A significant part of the bookings was made through digital channels. It can be said, that the indicator has reached a historical maximum in countries such as Israel, the USA, France,

[1] Ministry of Economy and Sustainable Development of Georgia, *News Release* (January 15, 2025), https://www.economy.ge/?lang=en&nw=2652&page=news.

the United Arab Emirates, Saudi Arabia, and other countries with high purchasing power. By 2026, in Georgia, the growth trend of tourist and international travelers' visits will be preserved. Marked international visits gradual growth, which is conditioned as global tourism is expected to be restored post-pandemic, during the period , as well as country tourist potential, actively promoted by popularization and digital marketing. 2026 january-march according to the data, there are 997,529 international tourist in Georgia. Tourist visits took place, which is 4%, 38,582 more than in 2025. Tourist visits growth in terms of 2026, the first quarter of the year recorded a new record-breaking indicator. Visitors in the top 15 neighboring countries are: USA , Great Britain, Germany, Poland, Israel, Kazakhstan, China, India, and other countries .[2]

Table #1

Number of international tourists in Georgia 2020-2026



During the 2019-2020 pandemic, tourists' numbers sharply declined. Then, in Georgia, the number of tour guides quickly increased. The tourism industry's stable growth showed, and for 2023–2024, before the crisis, the level reached. The growth in the number of tourists during this period was accompanied by an increase in the role of digital channels, as most consumers searched for and booked travel tickets online.Thus, tourism development in Georgia is tight in connection with digitalization, which is a main factor. In 2026 official data was published. [3]

According to the Georgia tourism sector, it continues stable growth in 2025. The number of accepted international travelers reached 7.8 million. Exceeded by about 5.9%. There is more, near the waist, compared to. During the period, the number of international tourist visits was 5.5 million. The results reached, and 8.4 % growth showed that visitors' growth, especially at night, is oriented in tourism, as it was recorded .[4] It is important. See also the fact that the 2025 year fourth quarterly tourist activity peak indicator reached: tourist visits quantity approximately 1.2 million, an increase of 10.5%, while international visits – approximately 1.7 million, an increase of 7.6%. [5]This dynamic confirms that Georgia, to this day, maintains a position as a growing tourist destination, with the country and the post-pandemic period. During the period, not only returns, but in a row, in cases, exceed the 2019 indicators.

Tourism indicators growth in Georgia is conditional, only one factor, although digital marketing and online platforms development has an important influence, as mentioned in the trial. International tourism modern trends considering the users' decision acceptance process is significantly related to digital space, where online reservation systems, users' assessments, and social media content play an important role.

The growth of tourism in Georgia is not due to just one factor, although digital marketing and the development of online platforms have a significant impact on this process. Given the current trends in international tourism, the consumer decision-making process is significantly connected to the digital space, where online booking systems, customer reviews and social media content play an important role.

The aim of the study is to identify the main directions of digital transformation in hotel chain marketing and assess their impact on the development of the hotel industry in Georgia. To achieve this goal, it is necessary to analyze modern digital marketing channels and tools, study the specifics of online distribution and dynamic pricing, and determine the role of digital technologies in creating competitive advantages for hotel chains.

Literature review

1. Service marketing fundamental and theoretical basics formed philip kotler , christian grönroos - , valarie a. Zeithaml - isa and mary yes bitner 's on the works based on , especially in the book , services marketing : integrating customer focus across the firm, authors : valarie a. Zeithaml , mary yes bitner

[2] National Statistics Office of Georgia (Geostat), *Inbound Tourism*, https://www.geostat.ge/en/modules/categories/102/inbound-tourism.

[3] Georgian National Tourism Administration (GNTA), *Tourism Statistics* (2026), cited in Civil.ge, *Tourism Statistics Report* (2026), https://civil.ge/archives/717769.

[4] National Statistics Office of Georgia (Geostat), *Inbound Tourism Statistics (2025)*, January 30, 2026, https://www.geostat.ge/en/single-news/3658/inbound-tourism-statistics-2025.

[5] National Statistics Office of Georgia (Geostat), *Inbound Tourism Statistics: IV Quarter 2025* (2026), https://www.geostat.ge/en/single-news/3659/inbound-tourism-statistics-iv-quarter-2025.

, dwayne d. gremler . First published: 1996. Latest edition: 8th edition (2022). Primary focus: service quality, customer relations, and firm integration. Publisher: mcgraw-hill, where service marketing, modern models, and about the user-oriented approaches are discussed in detail.

2. According to dave chaffey, digital marketing represents the use of digital channels to achieve marketing goals (chaffey & ellis-chadwick, 2019). Philip kotler 's concept according to modern marketing, moving to the marketing 4.0 stage , which is based on digital communication and consumers' active engagement (kotler et al., 2017).[6]

3. By dimitrios buhalis and andrea inversini. According to digital technologies, it represents a transformation, one of them, basically driving power . Their research shows that online platforms and digital agencies (online travel agencies) are modern in tourism, important as mediators. They appear to us , who connect service suppliers and users, and influence. They are doing market on structure (buhalis , 2003; buhalis & inversini , 2014)[7]

Research methods: research-based, theoretical, and empirical methods are used in the literature review, comparative analysis, and statistical data processing, which provides an in-depth study of the issue.

Basic text

In Georgia, digital channels are playing a dominant role. With tourists, the related decision acceptance is in process. Recent research shows that according to the hotel's reservation, more online bookings are carried out by users. Important part: use of mobile devices. Social media (Facebook, Instagram, and Tiktok) is also an important influence on hotel choice, because it helps to build brand trust and provides consumers with access to reviews. Important changes in progress hotel service, also in distribution . Online tourist agencies and digital platforms development caused a new sales system. The emergence of intermediaries plays an important role, providing global audience access. Online distribution hotels networks allow expanding sales scales, reducing transaction expenses, and increasing price transparency.

A key element of marketing transformation is the introduction of dynamic pricing based on data analysis. Modern hotel companies use specialized systems that adapt prices to demand, seasonality, and competitive conditions. This contributes to more effective revenue management and increased occupancy. Such approaches are becoming essential for the successful functioning of hotel chains in a competitive environment. Digital technologies are also significantly changing customer relationship processes. The use of big data and artificial intelligence allows hotels to analyze customer preferences and create personalized offers. This contributes to increasing customer satisfaction and loyalty. In Georgia, large hotel chains are gradually introducing customer relationship management systems and analytical tools, which allows them to adapt to the requirements of the digital environment. The development of omnichannel marketing, which ensures the integration of various channels of customer relationship, is of particular importance.

Thus, the digital transformation of hotel chain marketing is leading to the emergence of a new model of customer engagement based on the use of digital technologies, data, and innovative advertising tools.

Table#2

Global tourism market and digitalization (2021–2026)

The aforementioned data shows that the global tourism market is in full recovery in 2019 from the crisis, and 1.6 trillion dollars in 2024 dollars was reached. [8]It is noteworthy that the 24% increase in 2023 growth , which indicates restrained growth, is due to the request and industry's haste for digitalization.[9]

The growth of online channels to 65% confirms that digitalization is not a temporary trend, but a sustainable feature of the industry. From the perspective of economic theory, this means a transition to a digital platform market model in which technology, data and network effects play a key role. Mobile

[6] Chaffey, D., & Ellis-Chadwick, F., *Digital Marketing: Strategy, Implementation and Practice* (Pearson, 2019). Kotler, P., Kartajaya, H., & Setiawan, I., *Marketing 4.0: Moving from Traditional to Digital* (Wiley, 2017).

[7] Buhalis, D., *eTourism: Information Technology for Strategic Tourism Management* (Pearson, 2003). Buhalis, D., & Inversini, A., *Tourism and ICT: Transformations of Tourism Business Models* (2014).

[8] Phocuswright, *Global Travel Market Report* (2024)

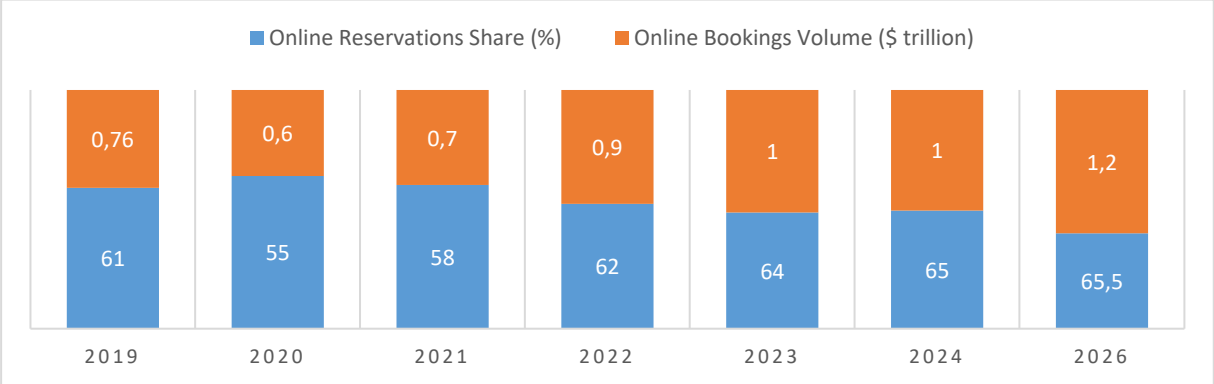
[9] Phocuswright, *Travel Industry Recovery Analysis* (2025).

applications further strengthen the individual relationship with the customer, as they provide personalized offers and loyalty programs and free access to fast service. In addition, messaging platforms (for example, WhatsApp, Tik-Tok and Facebook Messenger) create the possibility of instant communication, which increases the efficiency of service and customer satisfaction. A special role is also assigned to online travel agencies (OTA - Online Travel Agency), as well as Booking.com, Airbnb and Expedia, which function as intermediaries between hotels and customers and significantly influence the customer's choice and booking process.

By 2026, approximately 69.6% of tourism services will be sold through online channels (Statista, 2025), [10]which confirms the deepening digital transformation of the tourism sector. This trend is due to the widespread use of the Internet, the development of mobile technologies and the active use of online travel agencies (OTA), which have a significant impact on consumer behavior. This trend is consistent with the assessments of international organizations. The World Tourism Organization (UNWTO) emphasizes that the tourism sector is rapidly moving to a digital environment and the majority of consumers plan and book their trips through online platforms (UNWTO, 2023).[11]

Table #3

The dynamics of online bookings in the global tourism industry (2019–2026)

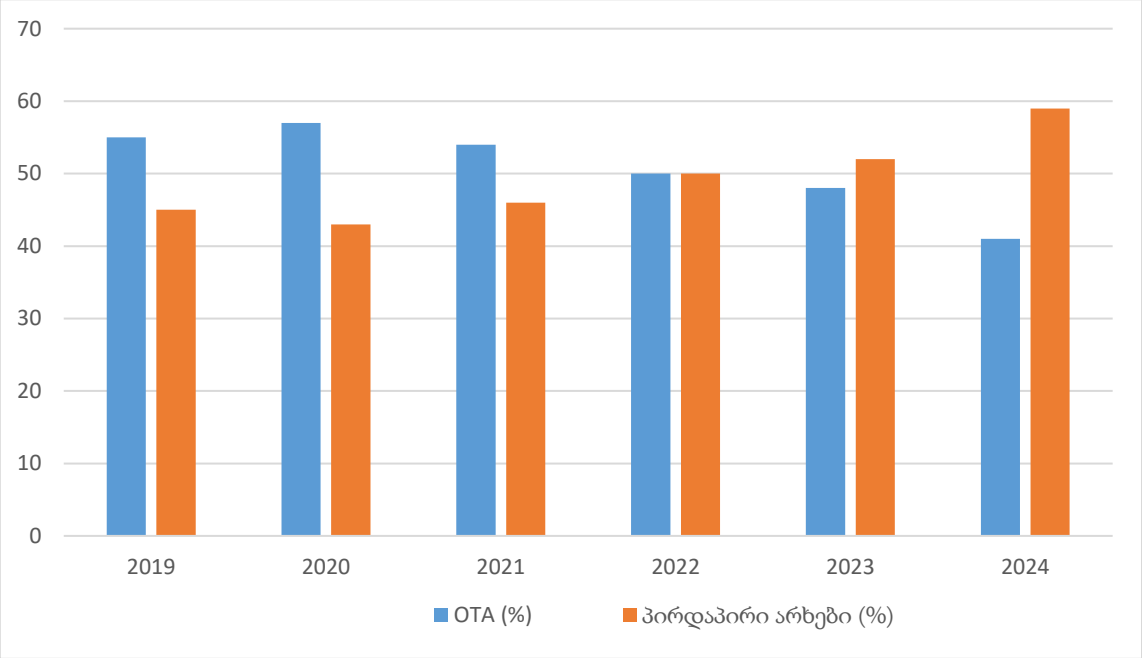


Presented data in 2020 showed that the covid-19 pandemic caused economic decline despite tourism in the industry, digital channels, and long-term structural growth. For 2022–2023, we see only restoration, but digitalization acceleration too. By 2024, online reservations are expected to reach about 1 trillion dollars, [12] and by 2026, growth is expected to reach 1.2 trillion dollars.[13] In the meantime, online reservations share about 65 %within will stabilize, which indicates that the market's digital maturity, according to the world bank, indicates that digital technologies represent tourism competitiveness. One of the basic factors and an important influence on consumer behavior and the market structure (World Bank, 2022).[14] The above circumstances confirm that in the modern world, online bookings and digital communication channels are emerging as a central component of the development of modern tourism.

[10] Statista, *Online Travel Booking Share Worldwide* (2025).
[11] United Nations World Tourism Organization (UNWTO), Tourism and Digital Transformation (2023).
[12] Phocuswright, *Global Travel Market Report* (2024).
[13] Phocuswright, *Online Travel Gross Bookings Forecast* (2025).
[14] World Bank, *Tourism for Development and Digital Economy* (2022).

Table #4

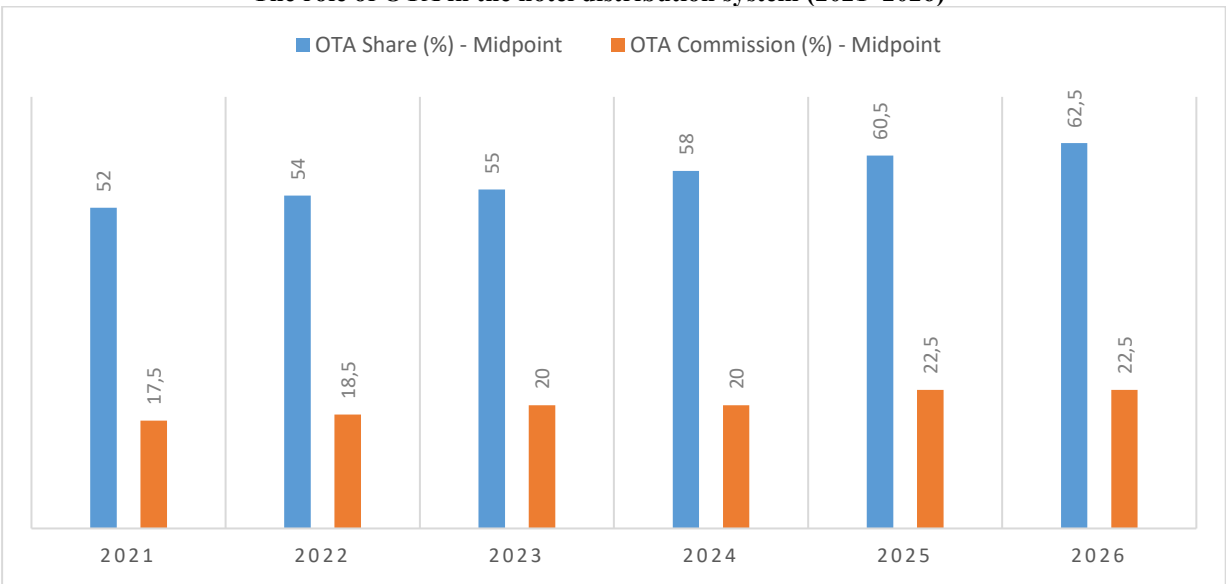
OTA vs. Direct channels (2019–2024)



An analysis of the online distribution structure reveals a significant transformation in the market balance. Despite that, before the pandemic, online OTA in sales dominated in 2022–2023. Direct channels begin growth in 2024. Direct online reservations share over 50% morereaches what conditional hotels are actively developing a strategy for their own sales channels and loyalty programs.[15]This trend reflects the hotel industry's attempt to reduce intermediaries and to increase consumer control over data. However , OTA again play an important role. They are performing on a global scale and for user convenience. Because of this , the market moves into a hybrid model, in which, simultaneously, platforms are getting stronger, as well as direct channels.[16]

Table #5

The role of OTA in the hotel distribution system (2021–2026)[17]



Data shows that OTAs consistently control more than half of the online booking market. Despite this relative stability, the platforms are gradually increasing their influence, especially in the independent hotel segment. Commission rates remain in the range of 15-25%, which puts significant pressure on hotel profitability. This confirms the platform-dependent distribution model emergence, where hotels are forced to balance global market access and financial stability with preservation in relation to .[18]

[15] Phocuswright, *Distribution Channels in the Travel Market* (2023).
[16] Statista, *Online Travel Bookings by Channel* (2024).
[17] Phocuswright, *Global Online Travel Overview* (2025).
[18] Statista, *Online Travel Agencies Market Share* (2026).

Table #6

The impact of digital technologies on hotel operations (2021–2026)[19]

Indicator	2021	2022	2023	2024	2025	2026
Revenue management	+8–10%	+10–12%	+12–15%	+15–20%	+15–22%	+18–25%
AI usage level	Medium	Above average high	High	High	Very high	Very high / mass
Service personalization	Low	Medium	High	High	High – very high	Very high

The presented analysis shows that digital technology implementation has an important effect. Despite that, revenue growth in 2021 moderate, by 2024, it is 15-20 %, will achieve what conditional revenue management systems and analytical instruments are active by introducing . [20]Increasing the level of personalization is particularly important, which directly affects customer satisfaction and repeat bookings. In addition, an important component of distribution is global distribution systems (GDS), such as Amadeus, Sabre and Travelport, which combine data from airlines, hotels and other travel services into a single platform and provide centralized access for travel agencies.

In Georgia, the online distribution market is last in terms of active development. At the present stage, it is gradually integrating with global digital tourists in the ecosystem of Georgia, in 2025 and continues to grow actively, which further strengthens the online distribution. According to the 2025 report, in Georgia, approximately 7.8 million international tourists visited, which is about 6% is more, and 5.5 million of them were tourists (overnight stay).[21] During the same period, spending by international visitors reached approximately 15 billion GEL, which also indicates an increase. These trends demonstrate that Georgia is increasingly integrated into the global tourism market. Against this background, the use of online travel agencies (OTA), including platforms such as Booking.com, plays an important role in managing tourist flows and increasing the international visibility of hotels, which ultimately becomes one of the main factors of their competitiveness.[22] These trends are particularly evident in the hotel market of the Georgian capital Tbilisi, which is one of the main centers of the country's tourism sector. The majority of hotels operating in Tbilisi actively use online platforms, such as Booking.com and Airbnb, to attract international customers. Based on data from the Georgian National Tourism Administration (GNTA) and the National Statistics Office of Georgia (GeoStat), the occupancy rate and number of visitors of Tbilisi hotels have increased significantly in the post-pandemic period, which is partly due to the active use of digital channels.[23]

Dynamic price formation modern hotel in industry represents revenue one of the revenue management central the instrument whose development too significantly speed up digital technology spreading data on analysis based decisions reception hotels allow gives in real life in time to regulate prices market conditions accordingly , which growth operational efficiency and financial results . [24]The above approach, based on multifactorial analysis, where decisive role completes seasonality, demand dynamics, consumers' behavioral features, and competitive environment, which jointly determine prices, flexible strategy[25].

In the Georgian context, the hotel sector is actively implementing revenue management systems, which is especially noticeable in large tourist centers such as Tbilisi and Batumi. [26] According to data from the Georgian National Tourism Administration (GNTA) and the National Statistics Office of Georgia (GeoStat), the increase in visitor numbers and fluctuations in demand in the post-pandemic period have further strengthened the need for dynamic pricing. Implementing these systems allows hotels to increase the profitability of their room inventory, optimize occupancy, and more accurately predict demand.

International research confirms that the effective use of dynamic pricing and revenue management systems significantly contributes to the growth of hotels' financial performance. In particular , the implementation of the above-mentioned approaches may lead to a 10–20% of revenue growth , which, according to the data, is based on the importance of modern tourism in the industry [27]

Right here, it should be noted that big data and artificial intelligence (AI), modern digital marketing, represent one of the main determinants. The factor that significantly shifts with the customer relationship

[19] McKinsey & Company, *Travel Industry Digital Transformation Report* (2023).
[20] Deloitte, *Hospitality Industry Outlook* (2024).
[21] National Statistics Office of Georgia (Geostat), *Inbound Tourism Statistics (2025)* (2026)
[22] Georgian National Tourism Administration, *Tourism Statistics Report 2025* (2026).
[23] Georgian National Tourism Administration (GNTA), *Statistical Overview* (2025); National Statistics Office of Georgia (Geostat), *Inbound Tourism Statistics* (2025).
[24] Buhalis, D., *eTourism: Information Technology for Strategic Tourism Management* (Pearson, 2003).
[25] Kotler, P., Kartajaya, H., & Setiawan, I., *Marketing 4.0: Moving from Traditional to Digital* (Wiley, 2017).
[26] Georgian National Tourism Administration (GNTA), *Statistical Overview* (2025); National Statistics Office of Georgia (Geostat), *Inbound Tourism Statistics* (2025).
[27] United Nations World Tourism Organization (UNWTO), *Tourism and Digital Transformation* (2023); Ivanov, S., *Hotel Revenue Management: From Theory to Practice* (2014).

models and the marketing decisions acceptance process .

The implementation of these technologies in the Georgian hotel sector is taking place gradually and is especially noticeable in large hotel chains, which are actively using customer relationship management systems (CRM), customer analytics platforms and automated marketing tools. According to data from the Georgian National Tourism Administration (GNTA) and the National Statistics Office of Georgia (GeoStat), the digital transformation of the tourism sector in Georgia is in line with global trends and reflects the growing market demand for technological innovations.[28] It is interesting to note that these processes contribute to improving service quality, increasing customer satisfaction, and strengthening business competitiveness, both in the local and international markets.

Conclusion

The digital transformation of hotel chain marketing is an objective and inevitable process, driven by both technological progress and a fundamental change in consumer behavior. The analysis of the Georgian example clearly shows that digital channels have already emerged as the main marketing tool that ensures effective customer relations and market positioning. The development of online distribution has significantly changed the sales structure and strengthened the role of digital platforms, which is especially reflected in the growing use of online travel agencies and direct online bookings. In addition, the introduction of dynamic pricing has contributed to increasing the operational efficiency of hotels, which is reflected in better demand forecasting and resource optimization. The use of big data and artificial intelligence creates the basis for a deeper customer-centric approach, which allows hotels to offer individually tailored services and improve customer experience.

In the context of digital transformation, it is advisable to activate the implementation of digital technologies and analytical tools to improve the effectiveness of hotel chains' marketing efforts. Special attention should be paid to the development of the company's internal online sales channels, which will reduce dependence on intermediaries and increase profitability. An important area is the implementation of data management systems and artificial intelligence technologies to provide personalized service. In addition, it is necessary to develop multi-channel customer engagement strategies that ensure a unified and seamless relationship with the customer. The main prerequisite for the successful implementation of digital strategies is also the improvement of the digital competence of the staff. In the long term, the development of digital marketing will contribute to the creation of sustainable competitive advantages for hotel chains and strengthen Georgia's position in the international tourism market.

To effectively address the challenges of digital transformation, it is necessary to implement a systemic and multifaceted approach in the Georgian hotel sector, increasing the availability of digital technologies. Subsidized technological solutions, grant programs and tax incentives will support the implementation of digital platforms and the use of innovative marketing tools. The presence of qualified personnel is critically important for the effective implementation of both data analysis and digital marketing and customer relationship management. In addition, special attention should be paid to the integration of data management systems (CRM, MIS), which will ensure the centralization of information about customers and will allow hotels to create personalized offers. Making data-based decisions will contribute to improving both service quality and optimizing business processes. In order to reduce high dependence on online platforms, it is recommended to develop direct sales channels, including strengthening the official websites and mobile applications of hotels. The introduction of loyalty programs and the creation of personalized offers will contribute to customer retention and an increase in the share of direct bookings, which will reduce the impact of intermediary costs. It is also necessary to strengthen cybersecurity and personal data protection standards, which is very important for maintaining consumer trust and ensuring compliance with international requirements. It is worth noting that the introduction of appropriate regulations and improving technological security systems should become one of the priorities for the development of the sector.

Ultimately, effective digital transformation requires collaboration between the state and the private sector, including joint strategies, infrastructure development, and innovation support. Such a coordinated approach will ensure the sustainable development of Georgia's hotel business and its successful integration into the global digital tourism market.

References

1. Buhalis, d. (2003). *Etourism: information technology for strategic tourism management*. Pearson.

2. Buhalis, d., & inversini, a. (2014). *Tourism and ict: transformations of tourism business models*.

3. Chaffey, d., & ellis-chadwick, f. (2019). *Digital marketing: strategy, implementation and practice* (7th ed.). Pearson.

4. Deloitte. (2024). *Hospitality industry outlook*.

5. Georgian national tourism administration. (2025). *Statistical overview: inbound tourism statistics*.

6. Georgian national tourism administration. (2026). *Tourism statistics report 2025*.

7. Ivanov, s. (2014). *Hotel revenue management: from theory to practice*.

8. Kotler, p., kartajaya, h., & setiawan, i. (2017). *Marketing 4.0: moving from traditional to digital*. Wiley.

[28] Georgian National Tourism Administration (GNTA), *Statistical Overview* (2025); National Statistics Office of Georgia (Geostat), *Inbound Tourism Statistics* (2025).

9. Mckinsey & company. (2023). *Travel industry digital transformation report*.

10. National statistics office of Georgia (geostat). (2026). *Inbound tourism statistics (2025)*. Https://www.geostat.ge/en/single-news/3658/inbound-tourism-statistics-2025

11. National statistics office of Georgia (geostat). (2026). *Inbound tourism statistics: iv quarter 2025*. Https://www.geostat.ge/en/single-news/3659/inbound-tourism-statistics-iv-quarter-2025

12. National statistics office of Georgia (geostat). (n.d.). *Inbound tourism*. Https://www.geostat.ge/en/modules/categories/102/inbound-tourism

13. Phocuswright. (2023). *Distribution channels in the travel market*.

14. Phocuswright. (2024). *Global travel market report*.

15. Phocuswright. (2025a). *Global online travel overview*.

16. Phocuswright. (2025b). *Travel industry recovery analysis*.

17. Phocuswright. (2025c). *Online travel gross bookings forecast*.

18. Statista. (2024). *Online travel bookings by channel*.

19. Statista. (2025). *Online travel booking share worldwide*.

20. Statista. (2026). *Online travel agencies' market share*.

21. United nations world tourism organization (unwto). (2023). *Tourism and digital transformation*.

22. World bank. (2022). *Tourism for development and digital economy*.

23. Ministry of economy and sustainable development of Georgia. (2025, january 15). *News release*. Https://www.economy.ge/?lang=en&nw=2652&page=news

24. Civil.ge. (2026). *Tourism statistics report*. Https://civil.ge/archives/717769

ASSOCIATION BETWEEN CORPORATE FINANCIAL PERFORMANCE AND ESG RATINGS OF PUBLIC COMPANIES: AGGREGATE REGRESSION ANALYSIS

Svetlin Minev
Assistant Professor
University of Economics – Varna
Knyaz Boris I Blvd 77, 9002 Varna, Bulgaria
DOI: 10.5281/zenodo.20607400

Abstract

ESG ratings have become a primary tool to evaluate how sustainably public companies operate and how they perform on non-financial metrics. Most of the studies so far have focused on how ESG factors influence corporate financial performance (CFP), while the reverse relationship has received less attention. This article analyses whether and to what extent corporate financial performance affects ESG ratings. The study is based on a cross-sectional regression analysis using ESG ratings from LSEG Data & Analytics and a range of CFP indicators. The results show a statistically significant but moderate relationship between CFP and ESG ratings, with company size and operating efficiency having a positive impact, while market multipliers and ownership structure show a negative relationship.

Keywords: ESG ratings, corporate financial performance, sustainability, regression analysis, non-financial reporting

1. Introduction

The topics of corporate social and environmental responsibility and responsible investment have been present in the literature for several decades, but have gained particular relevance in the last two decades [1]. Some of the main reasons are increased regulatory pressures, societal expectations, and the growing role of sustainable finance [2]. The concept of ESG as a tool for assessing the long-term sustainability of companies is increasing in popularity and as a result, the link between ESG ratings and CFP has become an important topic in academic research. [3]. Nevertheless, the majority of empirical studies examine how ESG factors influence financial performance (ESG - CFP) and have mixed and often contradictory results, with positive, negative, or mixed relationships observed [2]. Some studies have found a positive relationship between ESG and metrics such as ROA, Tobin's Q, and market capitalization, while others have found negative effects or no statistically significant relationship [4]. Significantly less attention has been paid to the inverse relationship – whether CFP affects ESG performance. Existing research on this relationship is limited in scope and often focuses on individual sectors or specific ESG components [5]. This creates a research gap in understanding whether good financial standing is a prerequisite for higher ESG ratings.

This study focuses on this less explored direction of the relationship between ESG and CFP. The main objective is to examine whether companies with better financial performance achieve higher ESG ratings, which would support the theoretical arguments of the slack resources theory and the resource dependence theory [6]. The analysis is carried out at the aggregate level in order to assess the CFP - ESG relationship. The present study extends this literature by combining a broad set of financial indicators - covering size, profitability, market valuation, and ownership structure - in a single aggregate cross-sectoral model applied to a global large-cap sample, thus enabling systematic comparison of predictor patterns across dimensions not previously examined jointly.

2. Theoretical Framework and Literature Review

The two-way relationship between ESG and CFP can be explained by several complementary theoretical frameworks. Stakeholder theory assumes that companies that balance the interests of different groups strengthen their reputation and create the conditions for sustainable growth [7]. Resource dependence theory emphasizes the strategic importance of external resources and relationships, suggesting that by implementing effective ESG policies, firms can reduce risk and dependence on the external environment and improve their long-term sustainability [6].

Signaling theory considers ESG disclosure as a signal under conditions of information asymmetry. Companies with better ESG performance have an incentive to disclose more extensive and higher-quality information, while companies with poor performance may limit or distort disclosures, which increases the risk of greenwashing [8]. Agency theory focuses on principal-agent conflicts and suggests that good corporate governance (the G component) reduces agency costs and improves efficiency and sustainable growth [9]. According to the theory of shareholder supremacy, maximizing shareholder wealth is a top priority of the firm, and making this priority a social norm is the biggest barrier to implementing ESG principles [10].

ESG ratings are used for assessing the performance of companies in the areas of environmental protection, social responsibility and corporate governance, as well as the risks associated with their sustainable development. One of the main objectives in calculating them is to reduce the information asymmetry between the company and stakeholders and to make it easier for investors to identify companies in good financial condition and at the same time distinguished by high responsibility to society and the environment [11]. The most popular are the ESG ratings of specialized agencies such as MSCI, Morningstar Sustainalytics, Bloomberg, and LSEG Data & Analytics, but due to the application of different methodologies, there are discrepancies between the rating providers [12].

The results of various studies on the relationship between ESG ratings and corporate financial performance suggest that the impact of ESG practices is mixed. The majority of studies have found a positive impact of ESG on CFP [2], but there is still no universally accepted model to conclusively confirm this relationship. In most cases, the observed correlations are weak, and there are many studies that show a mixed or even negative relationship [13]. Empirical studies analyzing the impact of CFP on ESG are significantly fewer. Some found a positive relationship, especially in terms of company size and profitability, while others did not find a statistically significant relationship or found negative effects in the short term [5], highlighting the need for further research.

3. Data and Methodology

The initial sample includes companies with a market capitalization exceeding USD 2 billion as of 31 March 2025. Financial and market data are primarily extracted from Yahoo Finance via Python (yfinance, pandas). ESG ratings are obtained from LSEG Data & Analytics due to their broad coverage and a 0–100 scale. The dependent variable in the regression model is the overall ESG rating. The independent variables include indicators of company size (market capitalization), profitability (ROA, operating and net margin), market valuation (P/S and P/B), five-year share returns, ownership structure (insider and institutional ownership), and the Piotroski F-score. The regression model is specified as follows:

$$TotalESG = \beta0 + \beta1\ ln(MCap) + \beta2\ ROA + \beta3\ OM + \beta4\ NM + \beta5\ 5ypf + \beta6\ P/B + \beta7\ P/S + \beta8\ IndrO + \beta9\ InstO + \beta10\ P_F + \varepsilon$$

where the independent variables are defined as follows:

ln(MCap) - Natural logarithm of the company's market capitalization

ROA - Return on assets

OM - Operating margin

NM - Net margin

5ypf - Five-year return on stocks

P/B - Price-to-book ratio

P/S - Price-to-sales ratio

IndrO - Insider ownership

InstO - Institutional ownership

P_F - Piotroski F-score

During data processing, companies without an ESG rating or key CFP indicators were removed. Missing values accounted for less than 5% of observations per variable and were replaced with values from StockAnalysis.com and FINVIZ.com, verified manually for consistency. After all exclusions, the final sample comprised 748 companies (68 per GICS sector). The pre-processing is made through winsorization, log transformation of market capitalization, and standardization of independent variables using z-scores. Fractional logit and beta regression were considered given the 0–100 bounded scale of ESG ratings; however, OLS with robust standard errors was retained as the primary specification due to its interpretability and given that scores are not concentrated near the boundaries. The analysis is conducted at the aggregate level without sector fixed effects, which is a deliberate design choice to estimate average cross-sector associations.

4. Results

At the aggregate level, the regression model is statistically significant ($F = 28.79$, $p < 0.01$) and explains approximately 27% of the variation in ESG ratings ($R^2 = 0.2711$). The Breusch–Pagan test confirms the presence of heteroscedasticity ($p < 0.01$), therefore coefficient significance is interpreted using robust standard errors. The VIF values do not indicate problematic multicollinearity (maximum ≈ 2.23). Six of the independent variables are statistically significant at the 5% level. The results are presented in Table 1.

Table 1

OLS Regression Results (Dependent variable: Total ESG rating, N = 748)

Variable	Coef.	Std. Error	t	p > |t|
Const.	63.29	0.54	116.26	–
ln(MCap)	+6.15	0.59	9.84	0.0000
P/S	−4.80	0.65	−7.18	0.0000
IndrO	−4.38	0.55	−5.92	0.0000
5ypf	−1.89	0.56	−3.12	0.0019
OM	+2.99	0.80	2.95	0.0033
InstO	−1.59	0.57	−2.84	0.0046
P_F	+1.01	0.56	1.68	0.0928
NM	−1.14	0.80	−1.15	0.2516
ROA	−0.47	0.63	−0.76	0.4481
P/B	−0.38	0.58	−0.57	0.5682

Fractional logit and beta regression were considered given the 0–100 bounded scale of ESG ratings; however, OLS with robust standard errors was retained as the primary specification due to its interpretability and given that scores are not concentrated near the boundaries.

Market capitalization has a positive effect ($\beta \approx +6.15$), consistent with the fact that larger companies have wider resource and organizational capacity to implement and report on ESG policies. OM also has a positive effect ($\beta \approx +2.99$), suggesting that operational efficiency supports ESG engagement. The P/S ratio has a negative and significant effect ($\beta \approx -4.80$), as does the five-year return ($\beta \approx -1.89$), suggesting that growth expectations and strong stock market performance do not automatically translate into higher ESG ratings. Insider ownership has a negative effect ($\beta \approx -4.38$), while institutional ownership also has a negative but weaker effect ($\beta \approx -1.59$). The Piotroski F-score, ROA, and P/B are not statistically significant at $\alpha = 0.05$.

5. Discussion

The empirical results suggest that corporate financial performance has a statistically significant relationship with ESG ratings, but this relationship is moderate. At the aggregate level, the explanatory power of the model is approximately 27%, which is realistic for ESG models since a significant part of the variation in ratings is determined by non-financial factors and methodological features of ESG assessment. This is consistent with observations from meta-analyses that average correlations between ESG and CFP are often low [2].

The positive effect of company size is one of the most stable results and supports the slack resources logic and resource dependence theory. Large companies have the capacity to invest in ESG policies, and are under pressure from regulators, the media and the investors. The negative relationship between P/S and ESG can be interpreted as an indication that growth expectations and high market valuations often coincide with business strategies aimed at expansion and innovation, which are not always combined with prioritizing ESG. The negative effect of the 5 years return also suggests that strong stock market performance is not a condition for high ESG ratings. The most interesting result is the negative effect of institutional ownership. The institutional investors are seen as carriers of ESG pressures, but empirical measurement here probably captures their heterogeneity: passive funds, short-term institutional strategies, and mechanical index following can weaken the expected effect. It is also possible that high institutional ownership is more common in companies where focus is on valuation and growth rather than ESG as a management priority [14].

The regression model employed is cross-sectional and therefore does not allow for definitive causal inference and the possibility of reverse causality cannot be excluded. The findings should be interpreted as documenting systematic correlations rather than causal effects. ESG ratings are also based on provider-specific methodologies and inevitably involve a degree of uncertainty, which may add noise to the analysis results [12]. A notable limitation is the absence of sector fixed effects. ESG practices vary substantially across industries and some of the explained variance may partly reflect sector differences rather than CFP effects per se. Analysis examining whether the CFP–ESG association varies by sector represents an important avenue for future research.

6. Conclusion

The present study provides empirical evidence of a statistically significant relationship between corporate financial performance and ESG ratings of public companies at the aggregate level. The results suggest that better financial performance, creates favorable conditions for higher ESG performance, but does not automatically guarantee it. At the same time, market valuations and ownership structures have a more complex and often negative impact on ESG ratings, highlighting the limited role of purely financial factors in explaining sustainable corporate behavior. ESG ratings are formed under the influence of a wide range of non-financial factors, including the regulatory environment, corporate culture, and societal pressure. The findings contribute to the academic debate on the two-way relationship between ESG and CFP and suggest that financial performance should be viewed as a necessary but not sufficient condition for achieving high ESG standards [15]. Future research could further enhance understanding of this relationship by incorporating panel data, sector controls, and causal identification strategies.

References

1. Carroll AB. A three-dimensional conceptual model of corporate performance. Acad Manage Rev. 1979;4(4):497–505.

2. Friede G, Busch T, Bassen A. ESG and financial performance: aggregated evidence. J Sustain Finance Invest. 2015;5(4):210–233.

3. OECD. ESG investing: environmental pillar scoring and reporting. Paris: OECD Publishing; 2020.

4. Krishnan CNV, Yang J, Tan X. Do ESG factors matter? Businesses. 2024;4(4):566–581.

5. Testa M, D'Amato A. Corporate environmental responsibility and financial performance. Bus Strategy Environ. 2017.

6. Pfeffer J, Salancik G. The external control of organizations: a resource dependence perspective. New York: Harper & Row; 1978.

7. Arian A, Sands J, Rahman HU, Khatatbeh IN. Corporate social performance through instrumental stakeholder theory. Manag Decis. 2024. doi:10.1108/MD-11-2023-2108

8. Spence M. Job market signaling. Q J Econ. 1973;87(3):355–374.

9. Jensen MC, Meckling WH. Theory of the firm: managerial behavior, agency costs and ownership structure. J Financ Econ. 1976;3(4):305–360.

10. Sjåfjell B, et al. Shareholder primacy and corporate sustainability. Cambridge: Cambridge University Press; 2015.

11. Stamenova R. ESG ratings and their economic implications. UNWE Sci Pap. 2024;64(2):119–129.

12. Ertan E. An impact investment strategy. Rev Quant Finance Account. 2023;61(1):177–211.

13. You Z, et al. ESG and firm performance: a global perspective. Finance Res Lett. 2024.

14. Giese G, Shah D. ESG and financial performance: recent evidence. MSCI Research Report; 2024.

15. Damodaran A. The ESG movement: the good, the bad, and the ugly. New York: NYU Stern; 2021.

JURISPRUDENCE

THE IMPACT OF THE JUDGMENTS OF THE EUROPEAN COURT OF HUMAN RIGHTS ON THE IMPLEMENTATION OF CIVIL PROCEDURAL NORMS

Khurtsilava Robizon
Doctor Of Law, Associate Professor
Department of Law, Akaki Tsereteli State University, Kutaisi, Georgia
Khurtsidze Daviti
Department of Law, Akaki Tsereteli State University, Kutaisi, Georgia
DOI: 10.5281/zenodo.20608491

Abstract

The present article provides an analysis of the impact of the judgments of the European Court of Human Rights on the use of Georgian civil procedural norms and their relation to the imperative of ensuring the effective realization of the right to a fair trial. In the modern legal sphere, the increasing number of civil disputes and the demand for effective administration of justice create the need to strengthen procedural guarantees.

Civil proceedings, as a mechanism for the protection of violated or disputed rights, require not only a formally sound normative framework, but also the use of legal norms in accordance with international standards. In this context, the case-law of the European Court of Human Rights is of particular importance.

The article examines the legal nature of the judgments of the European Court of Human Rights, their binding force and "erga omnes" effect, as well as their role in shaping national judicial practice. Particular attention is paid to the use of Article 78 of the Civil Procedure Code of Georgia in relation to the institution of public notice, and to the case of Gakharia v. Georgia, which had a significant impact on the interpretation of procedural norms and the transformation of judicial practice.

The research demonstrates that the judgments of the European Court of Human Rights are not limited to the finding of an individual violation, but establish systemic standards that ensure the practical and effective protection of the equality of parties, the principle of adversarial, and the right to a fair trial. The paper argues that the implementation of Convention standards constitutes not only an international obligation, but also a mechanism for improving the quality of national civil proceedings.

In the research process, the methods of analysis and synthesis, logical analysis, and comparative legal analysis were used.

Keywords: European Court of Human Rights; Right to a fair trial; Civil procedure; Public notice

Introduction

The development and progress of society are based on certain rules of conduct.[29] The legal regulation of relations between persons is not merely a means of protecting the rights of specific individual subjects; rather, it serves as a prerequisite for establishing public order and ensuring their safety. Civil legal disputes become increasingly relevant over time. The transition to a market economy and the expansion of private-law relations have further increased the need for the timely and lawful resolution of civil conflicts.[30] The stability of civil circulation constitutes the foundation of private law. The State is an entity obliged to create a legal framework for the protection of individuals' rights that is genuinely oriented toward the practical realization of those rights.

The order established by legal norms is often violated, giving rise to disputes between individuals. It is one thing to have a system of substantive law regulating civil relations, and another to have clear procedural mechanisms for protecting rights that have been violated or become disputed. Modern legal reality requires the coordination of well-functioning substantive and procedural systems.

Civil procedure is regarded as one of the means of resolving private disputes..[31] "The current Civil Procedure Code of Georgia reflects the existing legal realities by ensuring the timely consideration of cases and, ultimately, promoting procedural economy and the protection of the parties' rights."[32]

Legal certainty and the transparency of proceedings are prerequisites for effective adjudication. Developed states strive to create such a system of adjudication that ensures the proper protection of the rights of both the plaintiff and the defendant.

The Georgian legislator seeks to create the normative basis for a highly qualified process; however, the result is directly measured by the practical interpretation of procedural norms by the law-applying authority. A codified norm may be legally sound and compatible with human rights, yet the court may interpret it in such a manner as to reject even the fundamental principles of law.

At the same time, there are frequent cases where the principle of procedural economy is unconditionally

[29] Liluashvili, T.; Liluashvili, G.; Khrustali, V.; Dzlierishvili, Z., Civil Procedural Law, Part I, Tbilisi, 2014, 54.
[30] Kobakhidze, A., Civil Procedural Law, "Sakartvelos Matsne", Tbilisi, 2003, 3–5.
[31] Sakara, N, The right to a fair trial and a modern civil procedure model, . Problems of legality. 2018. Issue 141, 65.
[32] Khurtsilava, R., "Filing an Appeal: Analysis of Article 364 of the Civil Procedure Code of Georgia," Justice and Law.

associated with a reduced period of consideration, and the law-applying authority attempts, as quickly as possible and while formally observing the law, to bypass the imperative of the legality and high quality of the process.

At the international level, the European Convention on Human Rights constitutes the legislative framework for the protection of human civil and political rights.,[33] while cases of violations of the rights guaranteed by this Convention are examined by the European Court of Human Rights.[34] It is clear that the Convention is a guiding principle, the interpretation of which must correspond to "the general spirit of the Convention, which constitutes an instrument for the maintenance and promotion of the ideals and values of a democratic society."[35], whereas the European Court of Human Rights is the body that provides guiding interpretations in cases concerning disputes over human rights.[36] The European Convention on Human Rights has a significant impact on civil procedural legislation. It is often regarded as the basis for the Europeanisation of national legislation.[37] The interpretation of the European Court of Human Rights often stands even at the level of law and may become the legal basis determining the outcome of a dispute, especially in civil proceedings, which are based on the equality of the parties and the principle of adversarial.

The judgments of the European Court of Human Rights often also become a basis for changing uniform judicial practice. A clear example is the case of "Gakharia v. Georgia", which established such a standard for the use of Article 78 of the Civil Procedure Code of Georgia that does not serve the completion of proceedings within compressed time limits or the administration of civil justice in the absence of an uninformed party.

Based on the foregoing, it would not be inappropriate to assert unequivocally that the judgments of the European Court of Human Rights have a practical impact on the use of national civil procedural norms.

Judgments of the European Court of Human Rights as a Binding Recommendation for the Administration of Effective Civil Justice

At present, the protection of fundamental human rights constitutes the basis for the administration of a fair trial. The right to a fair trial, guaranteed by Article 6 of the European Convention on Human Rights and Article 47 of the Charter of Fundamental Rights of the European Union, "constitutes one of the most fundamental guarantees for respect for democracy and the rule of law."[38] For the purposes of civil proceedings, the European Charter establishes several elements of the fundamental right,[39] the fulfilment of each is possible only through well-functioning legislation and a well-functioning judicial system.[40]

It is well known that, at the national level, the protection of rights is carried out through the system of common courts. Although the principle of separation of powers recognizes the court as an independent body, the boundary of independence, of course, extends only to its institutional aspect.

The judicial system is obliged to familiarize itself with international legislative norms and practice and to administer justice only after their effective realization. If we examine more closely the system of protection of rights established by the European Convention, we can easily observe that it is three-stage. The first stage is the resolution of the problem at the national level by a court or a competent authority. The second is, in the event of the failure of the national system, the adoption of a judgment by the European Court of Human Rights concerning a violation of the Convention. The third and most important stage is the implementation of the adopted judgment within the national system.

It is precisely at the third stage that the role of the European Court of Human Rights in the use of legal norms becomes evident. If the European Court establishes that there has been a violation of the right to a fair trial, the Contracting State is obliged to remedy the damage.[41]

When interpreting a legal norm, a judge must necessarily examine the relevant practice.[42] For most member States of the Council of Europe, the judgments of the European Court of Human Rights (ECtHR)

[33] Leijten, I, Core Socio-Economic Rights and the European Court of Human Rights. Cambridge Studies in European Law and Policy, Cambridge Studies in European Law and Policy, 2017, 25.

[34] Tripkovic, B, Zysset, A, Uncovering the Nature of ECHR Rights: An Analytical and Methodological Framework, Human Rights Law Review, 2024, 24, 1–22, Oxford University Press, 1.

[35] Case of Kjeldsen, Busk Madsen and Pedersen v. Denmark (Application no. 5095/71; 5920/72; 5926/72), 7 December 1976, Series A no. 23, p. 27, § 53, https://hudoc.echr.coe.int/fre#{%22itemid%22:[%22001-57509%22]}

[36] Berski, A, The Role and Approach of the European Court of Human Rights in the Protection of Core Human Rights and in Deferring to the Judgment of States under the European Convention on Human Rights. Report prepared as a European Human Rights Assignment 2017, DIT, School of Languages, Law and Social Sciences, 3, https://arrow.tudublin.ie/cgi/viewcontent.cgi?article=1007&context=aaschlawrep]

[37] Krans, B, EU Law and National Civil Procedure Law: An Invisible Pillar, European Review of Private Law Volume 23, Issue 4 (2015), 567.

[38] C. Rozakis, 'The Right to a Fair Trial in Civil Cases', Judicial Studies Institute Journal 4.2 (2004): 96-106, p. 96, cited: Mańko, R, Europeanisationof civil procedure, Towards common minimum standards?, European Union, 2015.

[39] Particular attention should be paid to the right to an independent and impartial tribunal; the right to effective legal protection; the right to a fair trial; the right to a fair hearing; and the right to a hearing organized within a reasonable time, that is, without unjustified delay.

[40] Mańko, R, Europeanisationof civil procedure, Towards common minimum standards?, European Union, 2015, 5.

[41] Cavallini, D, Dallara, C, Guarnieri, C, Piana, D, The Implementation of the ECtHR judgements, 1.

[42] L. L. Fuller, 'Some presuppositions shaping the concept of "Socialization"', p. 39-40, cited: Bart van der Sloot, The Quality of Law, 11 (2020) JIPITEC 160 para 1, 182.

serve, at least, as a doctrinal source.[43] The European Court of Human Rights is often also referred to as a body that develops legal doctrine on human rights.[44] The European Court of Human Rights should be perceived neither as a first-instance nor as a fourth-instance court. Its authority does not consist in annulling the decisions of national courts; rather, the limits of its competence extend to establishing a violation of the Convention and awarding just satisfaction.

States, in turn, are obliged to comply with the judgments of the ECtHR, pursuant to Article 46(1) of the European Convention on Human Rights.[45] The European Court of Human Rights examines violations of the Convention by member States, while national courts examine compliance with Convention standards by State authorities.[46]

It is necessary to determine the scope of operation of the judgments of the European Court of Human Rights. The legal nature of the judgment itself is rather complex. A judgment of the European Court of Human Rights has an "erga omnes" effect.

At the same time, according to the principle of "*autorité de la chose interprétée*", the interpretation of a legal norm by the Court in a final judgment is binding for future cases, while the consequences of judgments go beyond the specific case.[47] In a broad interpretation, the subject of a judgment is not only the person whose right was specifically violated, but also society and the participants of the legal system within which the defective practice operates.

Consequently, the effective implementation of a judgment of the European Court of Human Rights does not imply only compensation for damage in respect of a specific person, but also includes the improvement of the legal sphere, as well as the refinement of legislation and national judicial practice.

The system established by the European Convention on Human Rights is based on the principle of subsidiarity, namely the fundamental idea that the Contracting States will fulfil their obligations in good faith.[48] "The mechanism for the protection of rights may be assessed as a circular system - national systems, the European Court of Human Rights, and national systems again - based on cooperation between the member States and the apparatus of the Council of Europe."[49] It is clear that a merely presumed obligation to protect rights cannot ensure an effective legal environment. States must analyse and practically implement the interpretations adopted by the European Court of Human Rights in relation to violations that have already been revealed.[50]

It is not surprising that, in many countries, courts have taken the initiative in developing quasi-constitutional mechanisms for the integration of the Convention. The supreme courts of developed countries are interested in closely monitoring the activities of the European Court of Human Rights and in implementing standards for the protection of rights.

Practice shows that, in most countries, the incorporation of the European Convention on Human Rights and the judgments of the European Court of Human Rights has increased the overall authority of national courts.[51] At the same time, the use of the case-law of the European Court of Human Rights assists courts in overcoming a number of problems, such as legal uncertainty, the disregard of the principles of good faith and justice, and the absence of effective mechanisms for the protection of rights.[52]

The Impact of the Judgment of the European Court of Human Rights on the Use of Article 78 of the Civil Procedure Code of Georgia

As already noted, the judgments of the European Court of Human Rights have a significant impact on the use of civil procedural norms. Georgian civil procedural doctrine unequivocally reinforces that the purpose of adjudication is the restoration of a violated or disputed right. According to the assessment of the European Court of Human Rights, the requirement of fairness extends to the judicial process as a whole.[53] At the same time, "the European Convention aims to ensure

[43] Barabash, O, Dobkina,K, Senyk, S, European Human Rights Standards: The Practice of Applying ECtHR Decisions, Informatol. 55, 2022., 1-2, 29.

[44] Viljanen, J, The Role of the European Court of Human Rights as a Developer of International Human Rights Law, University of Tampere, Finland, 249, https://www.corteidh.or.cr/tablas/r26759.pdf]

[45] Heri, C, Evidence: European Court of Human Rights (ECtHR), Encyclopedia entries, Max Planck Encyclopedias of International Law [MPIL], July 2018, https://opil.ouplaw.com/display/10.1093/law-mpeipro/e3431.013.3431/law-mpeipro-e3431

[46] Chanturia, L., "Application of the European Convention on Human Rights and Judicial Dialogue," Law Journal, no. 2, 2019, 6., https://jlaw.tsu.ge/index.php/JLaw/article/view/2874

[47] Bobryk, V, Bilianska, N, Petrovskyi, A, Mazur, V, Application of Article 6(1) of the ECHR in Civil Proceedings: The Effect of European Integration Processes on Ukrainian Legislation, European Journal of Sustainable Development (2025), 14, 4, 763/

[48] Case of Lutsenko v. Ukraine (Application no. 6492/11), Strasbourg, 3 July 2012, par 106, https://hudoc.echr.coe.int/eng#{%22itemid%22:[%22001-112013%22]}

[49] Cavallini, D, Dallara, C, Guarnieri, C, Piana, D, The Implementation of the ECtHR judgements, 3.

[50] Tsiklauri, S, Execution of Judgments of the European Court of Human Rights: Challenges at the National Level, Human Rights Center, 2022, 9, https://hrc.ge/files/238EXECUTION%20OF%20JUDGMENTS%20OF%20THE%20EUROPEAN%20COURT-eng.pdf]

[51] Keller, H, Sweet, S, Assessing the Impact of the ECHR on National Legal Systems, 686-688, https://openyls.law.yale.edu/server/api/core/bitstreams/ab182b19-48fe-4ed5-80a0-099c34964528/content

[52] Ivanets, I, The Impact of European Union`s Law and Judicial Practice on the Application of the Principles of Protection of Violated Civil Rights in the Ukrainian Judicial Proceedings, Nº 36 | Universidade Portucalense | Porto | 2024, Secção I Investigação Científica, Revista Jurídica Portucalense, 466.

[53] Case of Stran Greek Refineries and Stratis Andreadis v. Greece (Application no. 13427/87) , § 49, https://hudoc.echr.coe.int/eng#{%22itemid%22:[%22001-57913%22]}

rights that are not theoretical and illusory, but practical and effective."[54]

In one of its judgments, the Constitutional Court of Georgia notes that "the right to a fair trial, as a certain measure of the realization of the principle of the rule-of-law State, implies the possibility of protecting before a court all those interests which, by their essence, constitute a right. ... If there is no possibility or legal mechanism for preventing the violation of a right or restoring a violated right, the very enjoyment of that right will be called into question."[55] According to this interpretation, the body of constitutional control expressly indicates that the State is obliged to create such a legal mechanism which, when applied, ensures that the enjoyment of a right is not merely conditional.

According to the interpretation of the European Court of Human Rights, "the parties to a dispute must have an effective opportunity to present their positions."[56] This is reflected in the principle of equality before the court and the law,[57] according to which the participants in a case must enjoy equal legal guarantees. Each party must have the opportunity to present its position under conditions that do not place it at a disadvantage in relation to the opposing party.[58] The principle of procedural equality of the parties implies granting equal rights to the subjects of the proceedings. For example, if the plaintiff has the right to file a claim, withdraw the claim, recall it, and change its subject matter and grounds, the defendant is granted the authority to submit a defence and a counterclaim, as well as to acknowledge the claim.[59] Roman jurists already spoke of the origins of this principle. The principle of "*audiatur et altera pars*" implied the obligation to hear the defendant.[60]

Based on all of the foregoing, the State is obliged to create a system in which the filing of a claim, the submission of objections, and the conduct of proceedings are carried out without any discrimination. The principles of legality and procedural economy operate in procedural law. The restoration of a right cannot be effective if the parties and the court are not also restricted by time. "A judge must control the time limits and duration of proceedings from the very beginning of the case."[61] If the parties to a dispute are not assigned appropriate time limits for presenting their positions, the proceedings will continue for an indefinite period. There are frequent cases where the claim, together with the attached materials, cannot be served on the defendant at the correct address indicated by the plaintiff, while, at the same time, no other alternative address is known.

If a party is not informed, it will be unable to exercise the procedural rights granted by law. Under the Civil Procedure Code, the failure to submit a defence and non-appearance at the hearing may become grounds for rendering a default judgment.

It is clear that there must exist such a procedural mechanism under which a notice sent to the defendant will be deemed served, the time required for the administration of justice will not be prolonged indefinitely, and the conduct of proceedings will be in conformity with international standards.

Such a mechanism is precisely the public notice provided for by the Civil Procedure Code of Georgia. In its current wording, the norm consists of two parts: "1. If the location of a party is unknown or it is impossible to serve judicial summons in any other way, the court may, by its ruling, approve service by publication. Public dissemination of the court notice shall be carried out by hanging notification on a prominent place in the court building concerned or by placing it on a website, or at the request of an interested party, by publishing, at the party's expense, in the newspaper widely circulated in the administrative-territorial unit where the party resides, or by publishing in other media." 2. "In the cases specified in paragraph 1 of this article, judicial summons shall be deemed served on the party on the seventh day after the summons are placed at a prominent place in the court building concerned, or on a website, or published in a newspaper or other media. " Public notice constitutes one of the means of serving judicial acts or familiarizing parties with notice.[62]

The purpose of public notice is to prevent procedural actions from being carried out secretly. Developed countries successfully use this mechanism. According to the interpretation of the Supreme Court of the United States, although personal service is the most desirable method, public notice satisfies the requirements of due process guaranteed by the Constitution when other means of serving notice are

[54] Airey v. Ireland, § 24, Cited in: Supreme Court of Georgia, Guide on Article 6 of the European Convention on Human Rights: Right to a Fair Trial (Civil Aspects), 2.https://www.supremecourt.ge/uploads/files/1/pdf/adamianis-uflebata-centri/samartliani-sasamartlo-ganxilvis-upleba(samoqalaqo).pdf

[55] Decision No. 3/1/466 of the Constitutional Court of Georgia of 28 June 2010 in the case of The Public Defender of Georgia v. the Parliament of Georgia, II-14. https://constcourt.ge/ka/judicial-acts?legal=542]

[56] H. v. Belgium, (Application no. 8950/80), § 53, https://hudoc.echr.coe.int/eng#{%22itemid%22:[%22001-57501%22]}

[57] Civil Procedure Code of Georgia, consolidated version of 09/12/2025, Article 3, paragraph 1.https://matsne.gov.ge/document/view/29962?publication=174

[58] Kurdadze, Sh.; Khunashvili, N., Civil Procedural Law of Georgia, Meridiani Publishing House, Tbilisi, 2015, 95.

[59] Ibid., 98.

[60] Audiatur et altera pars - Oxford Reference, Fellmeth, A, Horwitz, M, Guide to Latin in International Law (1 ed.), Oxford University Press, 2009, https://www.oxfordreference.com/display/10.1093/acref/9780195369380.001.0001/acref-9780195369380-e-276

[61] Consultative Council of European Judges (CCJE), Opinion No. 6 (2004), "On Fair Trial within a Reasonable Time and Judge's Role in Trials Taking into Account Alternative Means of Dispute Settlement.", https://rm.coe.int/-ccje-6-2004-/168074739f

[62] Civil Procedure Code of Georgia, consolidated version of 09/12/2025, Article 78, https://matsne.gov.ge/document/view/29962?publication=174

practically impossible.[63] The current Georgian procedural law establishes two cases as procedural preconditions for the use of public notice: 1. where the locations of a party are unknown; 2. where the service of a court summons on a party cannot be effected by other means.[64] Public notice may be used where the rules governing the service of a summons have been observed. Normative regulation shows that the legal basis for both physical service of a summons/notice and service by means of public notice is foreseeable. However, in 2008, the actions taken by the national court in one of the cases became the subject of consideration by the European Court of Human Rights.

In the case of Gakharia v. Georgia, the applicant indicated that, as the defendant, the summons had been sent to him only once at the address indicated by the plaintiff. Although he was abroad and this fact was known to the plaintiff, the court did not apply the specific international treaty on mutual cooperation. At the same time, the means of serving the summons/notice had not been exhausted, and the use of public notice by the court was unlawful. The European Court of Human Rights noted that, first of all, the requirement of Article 73 § 1 of the Civil Procedure Code of Georgia had been violated, when "the court did not send the court summons to the applicant twice at the initial stage of the proceedings before carrying out public notice." The national courts could also have requested legal assistance from the relevant Contracting State to the Convention. At the same time, "no attempt was made to contact the local self-government authority or the local police department in order to establish the applicant's whereabouts (see, for example, mutatis mutandis, Dilipak and Karakaya, §§ 83–85, cited above). That means was also available to the court under Article 73 of the Civil Procedure Code (see § 15).".[65]

The European Court of Human Rights unequivocally noted that the dispatch of summonses and rulings on their publication in the media may serve a legitimate aim: to ensure the speed and effectiveness of proceedings. However, the present procedure could not be used to the detriment of other procedural guarantees, in particular, contrary to the principle of equality of parties.[66]

By way of conclusion, the European Court of Human Rights indicated that, for the purposes of our legislation, public notice is a measure of last resort. "Such an excessively formalistic approach by the national judges to the interpretation of the rules on serving court documents was unreasonable."[67]

This judgment revealed that a fair trial is achieved both through a properly functioning normative framework and through the good faith of the law-applying authority, as well as through the proper interpretation of individual procedural norms and guarantees. The European Court of Human Rights demonstrated that the existing legal regulation satisfied the requirements of fairness; however, the problem lay directly in the use of this norm. In this respect, the judgment had a decisive effect on the formation of judicial practice and doctrine. On the basis of the example discussed above, the problem of national courts in the use of the norms of the Civil Procedure Code became clear. The law unequivocally provides the judge with the possibility of using the resources of municipal bodies and/or the district services of the territorial bodies of the Ministry of Internal Affairs of Georgia for the service of a summons/notice.

By this judgment, the European Court of Human Rights created a precedent showing that judicial discretion is not merely a matter of will; it is the exercise, where necessary, of an authority granted by law, while public notice is a measure of last resort, which must be used only when other mechanisms have been exhausted. According to the standard established by the European Court of Human Rights, under the existing legal regulation, public notice must be preceded by at least two attempts to serve the summons, by giving an assignment to municipal bodies and to the territorial district services of the Ministry of Internal Affairs, and, where necessary, by sending the summons abroad in accordance with the procedure established by law.

However, it is one thing when the European Court of Human Rights establishes a violation and indicates to the State the essence of the problem, and another when the country itself ensures the effective implementation of the judgment. Today, judicial practice shows that the violations established by the European Court of Human Rights no longer occur. The court does not adopt a formalistic approach toward the defendant party. If we examine individual rulings on public notice, we may conclude that notification is disseminated publicly only where attempts have been made to serve it at the address indicated by the plaintiff and the involvement of the police has proved unsuccessful.[68]

Conclusion

The judgments of the European Court of Human Rights have essential and practical significance in the process of using national civil procedural norms. Although the Civil Procedure Code of Georgia, at the normative level, is consistent with international legal standards, the practice of the European Court of Human Rights clearly shows that decisive importance is attached not only to the content of a norm, but also to its

[63] Jennifer Lee Case, Extra - Read All about It: Why Notice by Newspaper Publication Fails to Meet Mullane's Desire-to-Inform Standard and How Modern Technology Provides a Viable Alternative, 45 Ga. L. Rev. 1095, 1126 (2011) at 1096, Cited in: Soliman, M, Electronic Publication of Legal Notice: Towards More Reasonably Calculated Means of Service, 3.

[64] Ruling of the Supreme Court of Georgia in case No. BS-1307-1292(k-ks-11), 12 December 2011.https://www.supremecourt.ge/ka/fullcase/17925/0

[65] Case of Gakharia v. Georgia, (Strasbourg, 17 January 2017, § 41.

[66] Ibid., § 44.

[67] Ibid., § 49.

[68] Ruling of Kutaisi City Court of 30 January 2026, case No. 2/2136-25; Ruling of Kutaisi City Court of 9 February 2026, case No. 2/3605-25; Ruling of Tbilisi City Court of 4 February 2026, case No. 2/22481-25; Ruling of Tbilisi City Court of 13 February 2026, case No. 2/32237-25.

interpretation and practical use. It is precisely in this context that the role of the European Court of Human Rights becomes evident, as an institution having both interpretative and systemic influence. The standard established in Gakharia v. Georgia clearly demonstrated that the principle of procedural economy cannot be used to the detriment of the equality of the parties and the right to a fair trial. Public notice, as a procedural mechanism, must be regarded as a measure of last resort, the use of which must be preceded by the exhaustion of all possible mechanisms provided for by law. The assessment of the European Court of Human Rights established that a formalistic approach to the interpretation of the rules on serving a summons violates the rights guaranteed by Article 6 of the Convention and thereby damages the legality and fairness of the proceedings.

On the basis of this judgment, national judicial practice was significantly transformed. Courts intensified the use of powers granted by law, including the involvement of the police and municipal bodies, the use of mechanisms of international legal assistance, and the carrying out of repeated attempts at service. As a result, public notice in practice has actually become a measure of last resort and not a formal procedural instrument.

All of the foregoing confirms that the effect of the judgments of the European Court of Human Rights is not exhausted within the limits of a specific case. They have systemic, preventive, and normative influence, which is reflected in the practice of national courts and in the development of legal culture. The implementation of Convention standards, especially in civil proceedings, ensures the practical and effective protection of rights, strengthens the principle of the rule of law, and increases public trust in justice.

It may be said that the case-law of the European Court of Human Rights constitutes not only an international obligation, but also a factor determining the quality of fairness in national adjudication, which is essentially based on the standard of the correct and human-rights-oriented use of civil procedural norms.

References

1. Civil Procedure Code of Georgia, consolidated version of 09/12/2025, https://matsne.gov.ge/document/view/29962?publication=174

2. Consultative Council of European Judges (CCJE), Opinion No. 6 (2004), "On Fair Trial within a Reasonable Time and Judge's Role in Trials Taking into Account Alternative Means of Dispute Settlement," https://rm.coe.int/-ccje-6-2004-/168074739f

3. Kobakhidze, A., *Civil Procedural Law*, "Sakartvelos Matsne", Tbilisi, 2003, https://dspace.nplg.gov.ge/bitstream/1234/409809/1/Samoqalaqo_Saproceso_Samartali_2003.pdf

4. Liluashvili, T.; Liluashvili, G.; Khrustali, V.; Dzlierishvili, Z., *Civil Procedural Law*, Part I, Tbilisi, 2014.

5. Kurdadze, Sh.; Khunashvili, N., *Civil Procedural Law of Georgia*, Meridiani Publishing House, Tbilisi, 2015.

6. Decision No. 3/1/466 of the Constitutional Court of Georgia of 28 June 2010 in the case of *The Public Defender of Georgia v. the Parliament of Georgia*, II-14, https://constcourt.ge/ka/judicial-acts?legal=542

7. Ruling of the Supreme Court of Georgia in case No. BS-1307-1292(k-ks-11), 12 December 2011, https://www.supremecourt.ge/ka/fullcase/17925

8. Ruling of Kutaisi City Court of 30 January 2026, case No. 2/2136-25.

9. Ruling of Kutaisi City Court of 9 February 2026, case No. 2/3605-25.

10. Ruling of Tbilisi City Court of 4 February 2026, case No. 2/22481-25.

11. Ruling of Tbilisi City Court of 13 February 2026, case No. 2/32237-25.

12. Case of **Gakharia v. Georgia** (*GAKHARIA v. GEORGIA*), Strasbourg, 17 January 2017, § 41.

13. Khurtsilava, R., "Filing an Appeal: Analysis of Article 364 of the Civil Procedure Code of Georgia," *Justice and Law.*

14. Chanturia, L., "Application of the European Convention on Human Rights and Judicial Dialogue," *Law Journal*, no. 2, 2019, 6, https://jlaw.tsu.ge/index.php/JLaw/article/view/2874

15. Airey v. Ireland, § 24.

16. Audiatur et altera pars - Oxford Reference, Fellmeth, A, Horwitz, M, Guide to Latin in International Law (1 ed.), Oxford University Press, 2009, https://www.oxfordreference.com/display/10.1093/acref/9780195369380.001.0001/acref-9780195369380-e-276

17. Barabash, O, Dobkina, K, Senyk, S, European Human Rights Standards: The Practice of Applying ECtHR Decisions, Informatol 55, 2022.

18. Berski, A, The Role and Approach of the European Court of Human Rights in the Protection of Core Human Rights and in Deferring to the Judgment of States under the European Convention on Human Rights, 2017, https://arrow.tudublin.ie/cgi/viewcontent.cgi?article=1007&context=aaschlawrep

19. Bobryk, V, Bilianska, N, Petrovskyi, A, Mazur, V, Application of Article 6(1) of the ECHR in Civil Proceedings, European Journal of Sustainable Development, 2025, 14(4).

20. Cavallini, D, Dallara, C, Guarnieri, C, Piana, D, The Implementation of the ECtHR Judgements.

21. Case of H. v. Belgium (Application no. 8950/80), § 53, https://hudoc.echr.coe.int/eng#{%22itemid%22:[%22001-57501%22]}

22. Case of Kjeldsen, Busk Madsen and Pedersen v. Denmark (Application no. 5095/71; 5920/72; 5926/72), 7 December 1976, § 53, https://hudoc.echr.coe.int/fre#{%22itemid%22:[%22001-57509%22]}

23. Case of Lutsenko v. Ukraine (Application no. 6492/11), Strasbourg, 3 July 2012, § 106, https://hudoc.echr.coe.int/eng#{%22itemid%22:[%22001-112013%22]}

24. Case of Stran Greek Refineries and Stratis Andreadis v. Greece (Application no. 13427/87), § 49, https://hudoc.echr.coe.int/eng#{%22itemid%22:[%22001-57913%22]}

25. Fuller, L L, Some Presuppositions Shaping the Concept of "Socialization".

26. Heri, C, Evidence: European Court of Human Rights (ECtHR), Max Planck Encyclopedias of International Law, July 2018, https://opil.ouplaw.com/display/10.1093/law-mpeipro/e3431.013.3431/law-mpeipro-e3431

27. Ivanets, I, The Impact of European Union's Law and Judicial Practice on the Application of the Principles of Protection of Violated Civil Rights in the Ukrainian Judicial Proceedings, Revista Jurídica Portucalense, 2024.

28. Jennifer Lee Case, Extra - Read All about It: Why Notice by Newspaper Publication Fails to Meet Mullane's Desire-to-Inform Standard and How Modern Technology Provides a Viable Alternative, 45 Ga. L. Rev. 1095 (2011), cited: Soliman, M, Electronic Publication of Legal Notice: Towards More Reasonably Calculated Means of Service.

29. Keller, H, Sweet, S, Assessing the Impact of the ECHR on National Legal Systems, https://openyls.law.yale.edu/server/api/core/bitstreams/ab182b19-48fe-4ed5-80a0-099c34964528/content

30. Krans, B, EU Law and National Civil Procedure Law: An Invisible Pillar, European Review of Private Law, 2015, 23(4).

31. Leijten, I, Core Socio-Economic Rights and the European Court of Human Rights, 2017.

32. Mańko, R, Europeanisation of Civil Procedure: Towards Common Minimum Standards?, European Union, 2015.

33. Rozakis, C, The Right to a Fair Trial in Civil Cases, Judicial Studies Institute Journal, 2004, 96.

34. Rosas, A, The Court of Justice of the European Union: A Human Rights Institution?, Oxford University Press, 2022.

35. Sakara, N, The Right to a Fair Trial and a Modern Civil Procedure Model, Problems of Legality, 2018, Issue 141.

36. Tripkovic, B, Zysset, A, Uncovering the Nature of ECHR Rights: An Analytical and Methodological Framework, Human Rights Law Review, 2024, 24.

37. Tsiklauri, S, Execution of Judgments of the European Court of Human Rights: Challenges at the National Level, Human Rights Center, 2022, 9, https://hrc.ge/files/238EXECUTION%20OF%20JUDGMENTS%20OF%20THE%20EUROPEAN%20COURT-eng.pdf

38. Viljanen, J, The Role of the European Court of Human Rights as a Developer of International Human Rights Law, https://www.corteidh.or.cr/tablas/r26759.pdf

CORRUPTION" AGAINST BATTLE LEGAL AND INSTITUTIONAL MECHANISMS COMPARATIVE ANALYSIS: GEORGIA AND DEVELOPED COUNTRIES "

Giorgi Kvaratskhelia
PhD student, Faculty of Law,
Grigol Robakidze University, Georgia
DOI: 10.5281/zenodo.20607471

Abstract

Corruption represents one by one of the most serious and multifaceted social, political, and legal challenges for the states (5, 13). It significantly makes it worse for democratic institutions, limits law supremacy principles, and weakens the defense of public governance and hand and prevents economic and social development stability (7, 14). The mentioned phenomenon is perceived not only as one specific country's challenge but also represents a global problem, which effective management requires legal, institutional, and social mechanisms to set (6,20).

Article: The goal is corruption against battle legal and institutional mechanisms: a comparative analysis in Georgia and developed countries in practice. Research based on doctrinal, normative, and comparative legal approaches that include international conventions, national legislation, specialized institutions, and fairly executed politics practices (18, 25).

Research Basic Conclusions shows that Corruption Against Effective Politics Requires Complexity And Integration The approach that combines:

• Preventive mechanisms, between public sector transparency and procurement processes electronization (3.9);

•Blood Law Responsibility Corrupt for actions (5, 14);

• Institutional Independence Strengthening and Investigative Organs' Professional Efficiency (11,21);

• International Cooperation Mechanisms to use Transnational Corruption Against (8,18);

• Civil Society, media, and non-governmental organizations' active engagement (17, 20).

Research as a result It is confirmed that Georgia's anti-corruption politics and legal framework are possibly significantly strengthened if the state masters developed countries' best practices (3.11) and maintains legal structure and international standards relevant to regulations (18, 25).

Keywords: Anti-corruption measures; Legal framework; Institutional effectiveness; Comparative analysis; International standards.

Introduction

Corruption represents one of the most widespread, multifaceted, and serious social, political, and legal phenomena in modern states' lives (5, 13). He includes public position abuse to use personal or group benefit acceptance for the purpose of which causes systemic problems as public in the administration, so country economic and social development (14, 16). Corruption limits fairness; it weakens competition. State Institutions' Authority, Fuzz Law, Supremacy, Protection, and Damage Put Democratic Governance (7,10).

Corruption Against Fight Special Importance Acquires Modern in the States, Because He/She Directly Connects Law Supremacy, Democracy Governance Quality, and Public Institutions' Efficiency Strengthening (2:20). Many countries admit that corruption is not only legal but also a structural and cultural problem that management requires legal norms, institutional mechanisms, and social control (6, 22).

International Justice Creates Numerous Mechanisms Against Corruption: For the fight, they use international conventions, recommendations, national legislation, legal norms, and specialized institutional bodies. For example, the United Nations Convention against Corruption (18) and the Criminal Law Convention on Corruption (25) define international standards for corruption criminalization, prevention, and international legal cooperation in the field.

A Modern Anti-corruption System Based on Legal, Institutional, and Social Control: A community that provides corrupt actions effective criminalization, prevention, legal execution mechanisms, institutions' accountability, transparency, and international cooperation (3, 9, 20). Successful anti-corruption politics requires complex, integrated, and multifaceted The approach that combines:

1. Legally regulating corrupt actions against (5,14);
2. Specialized and independent investigative organs (11, 21);
3. Public Sector Transparency and Accountability Instruments (3.17);
4. Civil Society, Media, and Non-governmental Organizations Monitoring and Control (17, 20);
5. International Cooperation and Experience Sharing Mechanisms (8, 18).

Georgia's example shows that the country has important progress in the anti-corruption institutional and legal framework in creation (21); however, existing challenges in institutional independence, preventive mechanism strengthening, and effective integration of international practices in the direction (20, 24) remain. In this context, Georgia's experience comparing developed countries is the best, with practices representing important instruments for anti-corruption politics, perfection, and practical results to improve (3,11).

Literature Review

Corruption represents a many-sided, sensitive phenomenon of study that requires integration. The approach: law, politics, economics, and administration in

the fields (4, 13). Legal Research According to corruption, it is perceived as public government abuse using personal or group interests to satisfy what violates public governance basic principles, fair competition, and law supremacy protection (5, 14). The above viewpoint highlighted such authors. In studies such as Rose-Ackerman (13) and Klitgaard (5), who are discussing corruption, it is not only a legal problem but also a complex social, political, and institutional challenge.

International Law Considers Corruption Against Battle Multifaceted Legally Framed (8, 18). Special meaning is assigned to international conventions, such as the United Nations Convention against Corruption (18) and the Criminal Law Convention on Corruption (25), which determine corruption criminalization, prevention, and international legal cooperation standards. The above International Legal Tools provide States with legal obligations, harmonization, and a hand; they are helping. Corruption Against United Politics and Practice Globally (24, 25).

International Organizations Studies: They are between Transparency International (17) and the Organization for Economic Co-operation and Development (9), under the heading "They are asking for institutions' independence, public sector transparency, accountability, and civil control's importance for effective anti-corruption politics to be created." TI's annual Corruption Perceptions Index (17) and the OECD Recommendations (9) show that corruption reduction is directly related to legal frameworks with fluency, public institutions with independence, and civil society with engagement (20, 21).

Monographs and academic works such as Lambsdorff (6), Heidenheimer & Johnston (4), and Treisman (16) line They are asking for a complex approach. The meaning that combines legal, institutional, social, and political mechanisms. They proposed models that show that effective management requires

1. Legal Regulations and Blood Law Responsibilities that They provide Corrupt Actions Criminalization and Legally Execution (5,14);
2. Institutional Control, which includes independent investigative bodies, audit services, and ethics commissions (11, 21);
3. Preventive Mechanisms: They are between public agencies, transparency growth, electronic governance, and public procurement processes monitoring (3.9);
4. Civil Society Engagement, Media Monitoring, and Non-Governmental Organizations Control, which Provides Accountability Additionally Level (17,20);
5. International cooperation, which is important. Transnational corruption, transportation, and asset back returns in case (8,18).

Comparative analysis shows that in developed countries, for example, in Singapore, in Germany, and in the USA, anti-corruption politics are based on a multilayered structure that combines strict legal norms, institutional independence provisions, preventive mechanisms, and civil society's active engagement (3.11). Georgia in context The above best practice implementation represents an important opportunity for anti-corruption politics, efficiency strengthening, and legal standards international with practice for harmonization phenomena (21, 24).

Except In addition , modern Research To the line They ask that Corruption Against Battle Efficiency Related Legal Norms Performance With quality , institutional With strength And Multidisciplinary Approach Using (6.20), which Requires As Academically , as well Political And Administrative Engagement (2.10).

Methodology

Prepared research based on normative, doctrinal, and comparative legal approaches that provide corruption against battle legal and institutional mechanisms and systematic analysis, as Georgia did, so developed countries in the context (3,21).

The normative method includes international conventions, organizational regulations, national legislation, and institutional acts (detailed analysis 18, 25). This approach allows for the determination of the legal definition of corruption, basic norms, and states' obligations that are connected to the prevention of corrupt actions and legally persecuting them (8, 18). Normative The analysis, particularly in light of UNCAC (18) and the Criminal Law Convention on Corruption (25), presents a research legal framework, supports it, and provides national regulations compliance globally with practice.

Doctrinal Analysis Based on International and Local Academic Literature, Monographs, Legal Documents, Policies, Reports, International Organizations Research, and Practical Court Acts (5, 6, 13). Doctrinal Approach by means of it happens to be a theoretical vision and practical experience synthesis, which allows corruption against battle effective mechanisms and existing problems and challenges to appear miscellaneous legally and institutionally in the environment (4,16).

The comparative legal method represents the main research instrument. It used Georgia's and developed countries' anti-corruption legal framework, institutional structures, legal norms, and systematic practice. For comparison (3, 11). Comparative Analysis Allow it to appear as flexibility, efficiency, and the best practice elements so that difficulties and challenges that may hinder corruption against effective event implementation (21, 24).

Research More: One Important It is characteristic of the multidisciplinary approach that combines law, political sciences, public administration, and social sciences accepted experience (2,10). This approach provides a multilayered strategy for battling corruption, perfect analysis, recognition of social, economic, and political phenomena, and the basis for practical recommendations for elaboration (6, 20).

Additionally, the study used qualitative analysis elements that were based on legal documents, practical cases, investigation reports, and international accounts discussion (2017). This method provides in-depth research, which combines theory and practice, which is necessary against corruption and effective politics for elaboration (21).

This methodological frame through MCM research not only describes existing legal and institutional mechanisms' efficiency but also shows possible directions.

Georgia Anti-Corruption Strategy Strengthening and International Experience For the inclusion (21, 24), which represents one by one the most important component, the state legal system development and democratic governance reinforcement are in process (20).

Comparative Analysis

Georgia

Georgia's Anti-corruption Legal Frame is at the very foundation based on the Blood Law Code, Civil Service Legislation, state audits, and public service regulatory acts (21:20). The above legal documents determine corrupt actions' criminalization, preventive responsibility, and institutional control mechanisms (5, 14).

Specialized institutions, between the civil service bureau and the state audit service, provide public sector transparency, accountability, and ethical standards protection control (21). They are also performing the corruption prevention function and providing public service professionalism and supervision (20, 21).

Georgia, in context, made important legal progress connected to international instruments, in particular the United Nations Convention against Corruption (18) and the Criminal Law Convention on Corruption (25) implementation. This, by way of Georgia, grants a legal harmonization opportunity internationally with the standards, which is especially important. Transnational Corruption Prevention and Legal Cooperation at the angle (8,18).

Despite progress, the existing system is suffering several basic challenges:

1. Institutional Independence Issue – Insufficient Autonomy Investigated From the Organs Political Pressure and Non-basic Interference (11,21);
2. Execution Efficiency – Legal Norms In Practice In Full To implement It Is Necessary Processes Optimization And Effective Monitoring (20, 21);
3. Preventive Mechanisms Integration – Existing Regulations Often Not Enough Coordinated, Which Hinders Systemic Control And Risks Prevention (3,9).

Developed Countries

Developed in countries, they are between Germany, Singapore, and the United States. Anti-corruption politics stands out multilayered and, in totality, coordinated with a system that combines legal, institutional, and social mechanisms (3, 11). In these countries, for example Especially it is striking:

1. Corruption Complete Criminalization – public and private in the sector, which provides legal execution consistency and legal violations effective punishment (5:14);
2. Independent And Financially Secured Investigative Bodies—Singapore Model (11) represents The best example is where independence, legal autonomy, and professionalism provide effective legal responses.
3. Public Administration Transparency – Electronic Governance, Open Procurement Systems, and Public Data Accessibility Through (3.9): Citizens and the civil sector will be given an opportunity for systemic control;
4. Civil Society Active Engagement—Media, NGOs, Organizations, and Civil Platforms' Participation Provides Public Control at an Effective Level and Hand It helps accountability increase (17, 20);
5. International Cooperation – Transnational Corruption In Cases Between States With Legal, Institutional, And Investigative Experience Fast sharing provides effective legal responses and asset returns (8,18).

Germany, Singapore, and the USA reveal such important features as corruption against legal frame perfection, institutions' independence guarantee, public sector transparency, and civil society involvement, which, important good luck, provides corruption reduction on the turn (6.20).

Comparative Conclusion

Georgia Anti-corruption System Comparison: Developed Countries Practice shows that the country has an important legal and institutional basis (21); however, it is necessary to:

- Institutions' Independence Strengthening (11, 21);
- Legal Norms Effective Execution Mechanisms Refinement (20);
- Preventive Mechanisms Systemic Integration (3.9);
- Civil Society Engagement and Public Control Increase (17, 20);
- International Practice The best experience adaptation is local with conditions (3.11).

Thus, Georgia will be able to corrupt against developing countries in battle. The best practice implementation, which significantly increases anti-corruption politics effectiveness, prevention, and prevention mechanisms quality as well, will help strengthen law supremacy (6, 20).

Conclusion

The research showed that corruptionone of the most serious challengesone of the most serious challenges represents One by one Most Serious Challenge for moderncorruptionfor modernModern For,, stateone of the most serious challengess damagingdamagingthat signiffor modernicantly Damage Plaw supremacy,,law supremacy,uts Law Supredemocratic governance, and state institutions' efficiencydemocradamagingtic governance, and state institutions' efficiencymacy , democratic governance, and state institutions' efficiency's anti-corruption's anti-corrulaw supremacy,ption (7.14). Georgiaexistence ofexistlegal and institutional framework provides legal norms for thelegal and institutional framework provides legal norms for theframework provides legal norms for the existence corrupt actions, prevention, andcorrupt actions, prevention, and, a for criminalization (5.18), while specialized bodiesspecialized bodiesthe Civilthe Civi such as Civil Serandandvice Burespecialized bodiesau And State Audit Servicethe Civila provide public sector transparency and accountabilitypublic sector transparency and accountability,, (21).

Howevr the Georgia, public sector transparency and accountabilitythe Georgia syssystem, istem is ananyway suffering several important challengethe

Georgias:yway suffering several important challenges:insufficient institutional system isInstitutions Insufficient independenceanyway suffering several important challenges:insufficient institutionalIndependence(11, 21), insufficient institutionalindependence(11,21), normslegal independence(11, 21),NormsPreventive Effective Execution Difficulties (20), (11, 21),normspreventive(3, 9), Mechanisms Insufficient Integration normsPreventive(3,9) ain Fullnd International Practice Preventive(3, 9),in Full Unapproved Implementation (24).

Developed With countries Comparison (3, 9),with countries, comparisonshows that Successful Anti-corruption Swith countries, comparisona successful anticorruptionystem Requires Complex , a successful anticorruptionsystem requires a complex,multi-layered, and integratedsystem requires a complex,, and integrated approach that Combines Legal combines legal,, institutional combines legal,,, social And International ,, and internationalmechanisms (6,16). , and international(6, 16).The above Approach Hand(6, 16).approach hand It helps Corruption Effective Prevention approach handcorruption effective prevention,, legal Execution Optimization And Public Institutions Authority Strengthening (corruption effective prevention,execution optimization, and public institutions' authority strengthening20, 21).execution optimization, and public institutions' authority strengthening.

Thus, Georgia Anti-corruption Politics Efficiency Increase Possible Developed Countries The best practice is adapted from 3.11, international standards considering 18.25, which Hand will help as a national, so global legal system integration (20).

Recommendations

1. **Institutional Independence Strengthening:** Needed Investigative And Preventive Organs Complete Autonomy Provision: They Create a Between Financial, Legal, And Administrative Independence Guarantees (11,21) to be put into effect Political From pressure Free Activity.

2. **Legal Execution Efficiency Provision:** Recommended Court Processes And Legal Events Efficiency Empowerment (20); Legal Norms Fast And Consistent Execution Mechanisms By Creation (5, 14).

3. **Preventive Mechanisms Systemic Integration:** It is important. Public Procurement, Administrative Decisions, and Electronic Governance Processes Optimization (3.9), which provides risks prevention and public information accessibility (20).

4. **Public Sector Transparency and Accountability Strengthening :** It is necessary Accountability Culture Reinforcement Public In agencies (17), regular Audits And Monitoring Structures Creation (21).

5. **Civil Society Engagement Increase:** Media, non-governmental organizations, and citizens' active engagement with corruption in revealing and in control will help accountability high standards to be established (17, 20).

6. **International Practice Usage:** Recommended Developed Countries Experience Adaptation Georgia is legally and institutionally harmonized with the system (3.11), especially transnational corruption, asset back return, and international cooperation in the fields (8.18).

7. **Multidisciplinary and Integrated Approach Introduction :** Corruption Against Fight I must be based on legal, economic, social, and political aspects synthesis (6.22), which provides systemic prevention and effective legal response (20).

References

1. Andvig JC, Moene KO. *How Corruption May Corrupt*. Bergen: Chr. Michelsen Institute; 1990.
2. Dye TR. *Understanding Public Policy*. 14th ed. Boston: Pearson; 2013.
3. European Commission. *Anti-Corruption Report: EU Best Practices*. Brussels: European Commission; 2014.
4. Heidenheimer AJ, Johnston M, LeVine VT. *Political Corruption: A Handbook*. 3rd ed. New Brunswick: Transaction Publishers; 2002.
5. Klitgaard R. *Controlling Corruption*. Berkeley: University of California Press; 1988.
6. Lambsdorff JG. *The Institutional Economics of Corruption and Reform: Theory, Evidence and Policy*. Cambridge: Cambridge University Press; 2007.
7. Mauro P. Corruption and Growth. *Q J Econ*. 1995;110(3):681–712.
8. OECD. *Convention on Combating Bribery of Foreign Public Officials in International Business Transactions*. Paris: OECD; 1997.
9. OECD. *OECD Guidelines on Anti-Corruption and Good Governance*. Paris: OECD; 2010.
10. Peters BG. *The Politics of Bureaucracy*. 7th ed. London: Routledge; 2010.
11. Quah JST. *Curbing Corruption in Asian Countries: An Impossible Dream?* Singapore: Eastern Universities Press; 2006.
12. Reinikka R, Svensson J. Local Capture: Evidence from a Central Government Transfer Program in Uganda. *Q J Econ*. 2000;115(2):679–705.
13. Rose-Ackerman S. *Corruption and Government: Causes, Consequences, and Reform*. 2nd ed. Cambridge: Cambridge University Press; 2016.
14. Shleifer A, Vishny RW. Corruption. *Q J Econ*. 1993;108(3):599–617.
15. Sung HE. *Corruption: Dimensionality, Consequences, and Economic Growth*. New York: Springer; 2004.
16. Treisman D. The Causes of Corruption: A Cross-National Study. *J Public Econ*. 2000;76(3):399–457.
17. Transparency International. *Corruption Perceptions Index 2022*. Berlin: TI; 2022.
18. United Nations Office on Drugs and Crime (UNODC). *United Nations Convention against Corruption*. New York: United Nations; 2003.
19. van Rijckeghem C, Weder B. Corruption and the Rate of Temptation: Do Low Wages in the Civil Service Cause Corruption? IMF Working Paper WP/99/63; 1999.
20. World Bank. *World Development Report 2021: Data for Better Lives*. Washington DC: World Bank; 2021.

21. World Bank. *Strengthening World Bank Group Engagement on Anti-Corruption*. Washington DC: World Bank; 2015.

22. You JS. *Corruption in Developing Countries: Causes, Consequences, and Reform*. Cheltenham: Edward Elgar; 2005.

23. Zhang T. Public Sector Reform and Anti-Corruption in China. *Public Adm Dev*. 2014;34(2):112–125.

24. European Union Agency for Fundamental Rights. *Corruption and Fundamental Rights in the EU: Comparative Analysis*. Luxembourg: EU Publications; 2016.

25. Council of Europe. *Criminal Law Convention on Corruption*. Strasbourg: Council of Europe; 1999.

OFFICIAL MISCONDUCT AND ITS LEGAL CONSEQUENCES

Lela Gudadze
Doctoral student
Scientific Supervisor: **Amiran Mosulishvili**
Doctor of Law,
Grigol Robakidze University
DOI: 10.5281/zenodo.20608540

Abstract

Official misconduct represents one of the most significant challenges within modern criminal law systems, as it directly affects the functioning of public administration, the rule of law, and public trust in state institutions. This article examines the concept of official misconduct, its legal nature, and its regulation under the current criminal legislation. Particular attention is given to forms of abuse of official authority, including abuse of power, negligence in office, bribery, and exceeding official powers. The study analyzes the existing legal framework and highlights both its strengths and shortcomings in practice. Despite the existence of comprehensive legal provisions, challenges remain in the effective enforcement of the law, including difficulties in evidence collection, institutional independence, and the persistence of systemic corruption risks. The article further explores development perspectives aimed at improving the legal response to official misconduct. These include strengthening anti-corruption mechanisms, enhancing transparency in public administration, improving legislative precision, and increasing the role of digital governance tools in reducing corruption risks. Overall, the paper concludes that effective prevention and prosecution of official misconduct require not only legal reforms but also institutional strengthening and increased public accountability.

Keywords: Official misconduct; criminal law; abuse of power; corruption; public officials; legal liability; public administration

Introduction

Official misconduct is one of the categories of crimes against the state and is regulated under Chapter 39 and 12 relevant provisions of the Criminal Code. Due to its specific nature, official misconduct is a matter of particular concern, as it directly affects the effectiveness of governmental functions, the level of public trust in public service, and the protection of democratic principles.

For modern states, transparency in administrative processes, fairness, and high standards of conduct for public officials are essential. In this context, the existence and effective application of criminal law mechanisms play a decisive role in preventing and addressing unlawful conduct and ensuring accountability for offenses committed by public officials.

Contemporary public governance is based on the principles of the rule of law, the concept of a legal state, and respect for the public interest. The foundation of such a system is an efficient and ethically responsible public service. However, in practice, there are frequent instances where public officials breach their official duties and use their positions for personal, political, or other unlawful purposes. Such conduct falls within the category of official misconduct, which represents not only a legal issue but also an ethical, social, and institutional challenge.

This paper aims to provide a comprehensive analysis of the legal nature of official misconduct, its criminal-law doctrine, and the regulatory framework in Georgia. It also examines the need for legal reform, international standards, and potential mechanisms for strengthening the rule of law in public service. Ultimately, the study seeks to develop recommendations for improving legal mechanisms for combating official misconduct and enhancing accountability within public administration.

The Criminal-Law Nature of Official Misconduct

Official misconduct represents one of the most complex and specific categories within criminal law, directly linked to the effectiveness of state governance, public trust in public service, and the protection of the principles of the rule of law. In criminal law doctrine, official misconduct is understood as an act or omission committed by a public official through the abuse or excess of official authority, which constitutes conduct contrary to the public interest.

Such offenses undermine the normal functioning of the state apparatus and are typically committed through the use of an official position in violation of the requirements of public service. A defining feature of official misconduct is the presence of a special subject: state officials or, more broadly, persons holding public office. These offenses can only be committed by individuals who occupy a position of authority and misuse their official powers. As a result, such conduct disrupts the normal functioning of public administration and governmental institutions.

This raises the conceptual question of who qualifies as a public official or a holder of public office. A state-political position is defined as a constitutional public office provided for by the Constitution of Georgia and the constitutions of the autonomous republics. Such positions are political in nature, and the procedures for appointment or election are determined by constitutional provisions.

Regarding public servants, under the Law of Georgia on Public Service, a public servant is defined as a person who performs remunerated duties within the

public service system in accordance with the provisions of the law.

The group of offenses known as official misconduct may be defined as socially dangerous acts or omissions committed by public officials or representatives of authority through the abuse of their official powers and in violation of the interests of public service. Such conduct causes substantial harm to the interests of state authorities or creates a real risk of such harm.

The object of official misconduct is the system of constitutional order guaranteed by the Constitution of Georgia, as well as the social relations arising within the sphere of public law. These offenses are distinguished from other types of criminal acts by several specific features. First, they are committed by a special subject—namely, state officials or persons holding public office. Second, they are carried out through the misuse or excess of official authority. Third, such conduct results in the disruption of the normal functioning of state and administrative bodies.

Among offenses within this category, bribery-related crimes are the most widespread and simultaneously the most dangerous. These include the giving and receiving of bribes (Articles 338 and 339 of the Criminal Code of Georgia). In addition, influence peddling represents a relatively recent legal development in criminal legislation. Although it is structurally similar to the offense under Article 339, there are significant legal distinctions between the two, which will be analyzed in subsequent sections of this paper.

Other important offenses include abuse of official powers (Article 332), exceeding official authority (Article 333), official forgery (Article 341), and negligence in office (Article 342). The acceptance of prohibited gifts (Article 340) is also a particularly relevant provision within this group of crimes.

A common feature of all the aforementioned offenses is the presence of a special perpetrator, meaning that they can generally be committed only through the use of official status. The only exceptions are the acts of giving a bribe and complicity in bribery, where the subject is not limited to public officials alone.

In judicial practice, cases involving bribery and trading in influence frequently raise issues of legal differentiation. As is well established, under the relevant provision of the Criminal Code, bribery refers to the direct or indirect acceptance or demand by a public official or a person equivalent to a public official of money, securities, other property, material benefits, or any other unlawful advantage, as well as the acceptance of an offer or promise thereof, for the benefit of the official or a third party. Such conduct is undertaken in exchange for the performance or non-performance of an act within the scope of official duties in favor of the bribe-giver or another person, or for the use of official authority to achieve a similar purpose, including acts of official patronage.

Trading in influence, on the other hand, refers to the act of a person who claims or confirms that they are able to exert improper influence over a public official or a person equivalent to a public official in the decision-making process. This involves the promise, offer, or granting of money, securities, property, material benefits, or other unlawful advantages, directly or indirectly, for the benefit of that person or a third party, by an individual acting in their own or another's interest, regardless of whether such influence is actually exercised or whether the intended result is achieved.

The similarity between bribery and trading in influence lies in the nature of the protected legal interest. In both cases, the primary objective of the legal norm is the eradication of corruption and the protection of the integrity of public administration.

The key distinction between these two offenses lies in the structure of the subject matter. In bribery, the recipient of the undue advantage is exclusively a public official or a person legally equated with a public official. In contrast, in trading in influence, the perpetrator is a private individual who claims the ability to exert unlawful influence over a public official or decision-maker and, in return, demands or receives a material or other benefit.

Furthermore, in bribery, the bribe-giver directly offers or provides an undue advantage to a public official. In trading in influence, however, the undue advantage is offered or granted to the intermediary who claims the ability to influence a public official or state decision-making process. This demonstrates that bribery is characterized by a bilateral corrupt relationship, whereas trading in influence involves a tripartite corrupt structure.

Current Legal Regulation in Georgia

The issue of liability for official misconduct represents one of the most significant and relevant topics in contemporary legal reality. Public officials, who act on behalf of the state and hold positions of public trust, are obliged to perform their duties strictly within the framework of the law. When they violate these obligations and abuse their official position, the question of legal liability arises. In such cases, both legal accountability and the strengthening of preventive mechanisms are of crucial importance.

Liability for official misconduct may take various forms, including criminal, administrative-disciplinary, and civil liability. Moreover, Georgian legislation provides that liability may also be imposed on legal persons, which is particularly important in the context of combating corruption-related offenses. A legal person may be held liable only for the commission of the offense provided for under Article 339[1] of the Criminal Code, namely trading in influence. However, this provision applies exclusively to private legal entities.

This regulation reveals a legislative gap, as numerous cases of bribery involving public legal entities or state institutions have been observed in practice. Nevertheless, it should be noted that a legal person ultimately constitutes a legal fiction, and the actual perpetrators of unlawful conduct are always individuals, namely public officials.

It is noteworthy that among offenses classified as official misconduct—such as abuse of official authority, exceeding official powers, bribery, and others—sanctions often include not only imprisonment but also the deprivation of the right to hold public office or engage in certain activities. This approach is both logical and justified given the nature of these offenses.

However, it is somewhat controversial that such additional sanctions are not предусмотрed (not imposed) in cases of official forgery (Article 341) or negligence in office (Article 342). Considering the specific nature and potential social danger of these offenses, the exclusion of such sanctions may be regarded as a deficiency in the legal framework, as both crimes arguably warrant the inclusion of disqualification from holding public office as an additional penalty.

The investigation and detection of official misconduct constitute one of the most important and, at the same time, most complex areas in the practice of criminal justice. Offenses of this category are typically characterized by a closed and less transparent nature and are directly linked to the abuse of official authority by public officials. Such crimes harm both the interests of the state and public trust in governmental institutions.

Due to the specific nature of official misconduct, its detection is often particularly challenging. Investigations are usually initiated on the basis of covert information, internal audits, journalistic investigations, or anonymous reports. Moreover, these offenses are frequently committed in a confidential manner among officials, which further complicates their detection and the collection of admissible evidence.

One of the main difficulties in investigation concerns the collection of evidence. Official documentation, which may constitute key evidentiary material, is often intentionally falsified or destroyed. Witnesses who could provide essential information are frequently either involved in the offense themselves or subjected to various forms of pressure, including psychological, institutional, or political influence. In addition, fear of law enforcement authorities often discourages individuals from freely providing information.

A significant obstacle in this context is also the factor of politicization. Official misconduct is often associated with high-ranking public officials, which increases the risk of political pressure on investigative bodies. In practice, it is not uncommon for liability to be imposed only on lower-ranking officials, while the actual instigators or organizers of the offenses remain outside the scope of investigation. Such practice seriously undermines the principle of the rule of law and public confidence in the public sector.

Investigative quality is further negatively affected by institutional deficiencies, including a shortage of qualified personnel, limited technical resources, and the absence of advanced analytical mechanisms. Addressing such offenses requires close cooperation among financial, economic, and legal experts, which is not always adequately ensured. As a result, investigative bodies often fail to conduct comprehensive forensic and analytical examinations, which hinders a thorough and effective investigation.

In addition to legal and institutional challenges, a fundamental problem is the low level of public trust in investigative authorities. Citizens frequently do not trust law enforcement institutions and therefore refrain from reporting offenses. This issue is particularly acute in regional areas, where fears of retaliation or professional harm are common. These factors significantly hinder public participation in the fight against corruption and delay the timely detection of offenses.

Accordingly, the investigation of official misconduct requires a systemic and comprehensive approach. It is necessary to strengthen law enforcement institutions, ensure their independence, provide specialized training for qualified personnel, improve the legal framework for covert investigative measures, and, most importantly, enhance public trust and civic engagement. Only under such conditions can effective detection of official misconduct and the real enforcement of justice be achieved.

In this regard, Article 70^1 of the Criminal Code is also noteworthy, as it provides that in exceptional cases, where cooperation with investigative authorities results in the identification of a public official or the perpetrator of a particularly serious crime, and such cooperation substantially contributes to the successful resolution of the case, the court is empowered to fully exempt the accused from criminal liability.

Official misconduct, which involves the abuse of powers by public officials in connection with their positions, remains one of the key challenges in Georgia. In recent years, the state has increased its efforts to combat corruption and ensure transparency within the public sector. Nevertheless, statistical data and judicial practice reveal both certain progress and persistent systemic problems.

According to data provided by the Ministry of Internal Affairs, 241 cases of official misconduct were registered in 2024, whereas in 2023 the number reached 400. Overall, a decreasing trend in official misconduct cases has been observed in recent years. Official statistics indicate that in 2024 the incidence of abuse of official authority decreased by 55.8%, bribery by 53.9%, exceeding official powers by 28.3%, giving a bribe by 28.6%, official forgery by 68%, and negligence in office by 37.5%.

However, particular attention should be paid to the relatively low clearance rate of such offenses. According to information published on the website of the Prosecutor's Office, 134 cases of exceeding official authority were registered in 2024, yet only 5 of them were successfully solved. A similar pattern was observed in 2023, when out of 187 registered cases, only 3 were resolved.

According to the Prosecutor's Office report for 2023, criminal prosecution was initiated against 87 public officials, including 41 employees of local self-government bodies, 21 officials from the Ministry of Internal Affairs, and 7 employees of the National Forestry Agency. In 2022, criminal proceedings were initiated against 118 public officials, including five employees of the Penitentiary Service and five employees of the Probation Agency. In that year, 27.8% of the cases concerned official forgery.

In 2021, the Prosecutor's Office initiated criminal proceedings in 117 cases. In 59 of these cases, employees of the Ministry of Internal Affairs were involved, while in the remaining cases officials from various institutions such as the Forensic Bureau, the State Security Service, and the Roads Department were implicated.

Overall, while statistical data indicate a gradual reduction in registered cases of official misconduct, the low detection and resolution rates highlight significant practical and institutional challenges within the law enforcement system.

Need for Reform and Development Perspectives

The fight against official misconduct remains one of the key challenges for modern states. The abuse of power by public officials, bribery, disregard for conflicts of interest, and financial misconduct undermine both democratic governance and economic development. In light of these risks, international organizations and intergovernmental bodies have developed various legal and institutional standards aimed at preventing official misconduct and ensuring its effective detection.

One of the most important international instruments in this field is the United Nations Convention against Corruption (UNCAC), adopted in 2003. The Convention not only defines various forms of corruption but also requires their criminalization, including bribery (both active and passive) embezzlement, money laundering, abuse of functions, and conflicts of interest. One of the most innovative aspects of UNCAC is the asset recovery mechanism, which enables states to reclaim illicitly transferred funds.

In addition, the Convention places strong emphasis on preventive measures, including increasing transparency in public administration, implementing codes of ethics, and enhancing professionalism in the public sector. Alongside the UN framework, the anti-corruption standards of the Council of Europe also play a significant role. In particular, the Group of States against Corruption (GRECO) provides monitoring and evaluation mechanisms for member states. GRECO issues recommendations on ethics standards, conflict of interest regulation, access to public information, and the financing of political parties, thereby assisting states in aligning their legal frameworks with best international practices.

The OECD Anti-Bribery Convention focuses on preventing the bribery of public officials by the private sector, which is particularly important for ensuring transparency in the global business environment. It requires member states to criminalize the bribery of foreign public officials, strengthen corporate accountability, and enhance international cooperation in investigations and mutual legal assistance.

The practical implementation of international standards varies across jurisdictions. One of the most notable examples is Singapore, widely regarded as a benchmark in anti-corruption policy. The country operates an independent Corrupt Practices Investigation Bureau (CPIB), which reports directly to the Prime Minister's Office and ensures strict oversight of high-ranking officials. Singapore's system is also characterized by relatively high public sector salaries, reducing incentives for bribery, and by strict and immediate sanctions for corruption offenses. Anti-corruption efforts are further reinforced through education, where ethics and civic responsibility are taught from an early age.

Sweden provides an interesting model in terms of transparency and good governance. It follows a strong tradition of open government, ensuring near-unrestricted public access to official documents. This principle of public access serves as a powerful tool for monitoring public officials. In addition, conflicts of interest are strictly regulated, and public officials are required to recuse themselves from decision-making processes whenever impartiality may be compromised. Sweden also extensively uses digital systems to enhance transparency in public administration.

Rwanda represents a notable example among developing countries. Over the past decade, the government has significantly reduced corruption levels through strong political will, independent anti-corruption institutions, and widespread use of digital technologies. Citizens can report misconduct anonymously through online platforms such as Irembo. The Rwandan experience demonstrates that effective anti-corruption policy is achievable even in low-income countries when based on transparency, oversight, and public participation.

In Georgia, anti-corruption reforms were particularly prominent in the early 2000s. Key reforms included restructuring the police system, introducing the "one-stop shop" principle in public services, and improving access to public information. Mechanisms for monitoring asset declarations of public officials were also established. However, in recent years, challenges remain regarding the independence of anti-corruption institutions and their protection from political influence.

Overall, international standards provide a foundational framework, while national practices demonstrate how these principles can be effectively implemented in specific contexts. Effective prevention of official misconduct requires not only strict legal regulation but also an ethical public administration culture, transparent decision-making processes, and active civic participation. These elements collectively form the basis of sustainable and accountable governance in the modern world.

The prevention of official misconduct represents a crucial task for modern states, where the quality of governance is directly dependent on the integrity and lawfulness of public officials. Criminal policy serves as an important instrument in this process, as it ensures legal responses to conduct that undermines the public interest, violates professional ethics, and weakens the foundations of democratic governance.

Through the establishment of behavioral boundaries for public officials, criminal policy seeks to prevent acts such as bribery, abuse of authority, disregard of conflicts of interest, and misappropriation of budgetary funds. The prevention of official misconduct is particularly significant in the context of developing countries, where corruption and administrative abuses may constitute systemic problems affecting democratic development and economic stability.

In Georgia, which for many years faced significant levels of corruption, important legal and institutional reforms have been implemented in this area. The country has taken substantial steps in developing criminal policy and anti-corruption strategies, gradually creating an environment in which public officials are subject to stricter standards of conduct, and public administration has become more transparent and accountable.

A key aspect of criminal policy in Georgia is that it not only punishes corrupt conduct by public officials but also seeks to prevent it. One of the earliest and most significant reforms was the police reform of 2004, when the government fundamentally restructured the police system and systematically addressed corrupt practices within it. The conditions of public service for police officers were significantly changed: salaries were increased, working conditions were improved, and strict liability for corruption was introduced. At the same time, control mechanisms were strengthened to ensure transparency in police activities.

The strict implementation of criminal policy was essential for reducing corruption levels in the country. From 2004 onwards, the Georgian government increased sanctions for corrupt offenses and introduced a system for monitoring asset declarations of public officials, aimed at preventing the abuse of power. All public officials were required to submit asset declarations, which were subject to verification and monitoring for accuracy and compliance.

At the same time, the strengthening of the rule of law and the independence of the judiciary significantly improved the effectiveness of legal institutions, which was essential for uncovering and prosecuting corruption-related crimes. The Georgian example clearly demonstrates that criminal policy is one of the most effective tools for preventing official misconduct.

The government also established national anti-corruption structures, which coordinate anti-corruption activities, while legal reforms introducing strict sanctions for bribery and abuse of office have contributed to improving the reputation of the public sector. Such measures function as preventive mechanisms, sending a clear message to public officials that they are accountable for their actions and that any misconduct will be subject to criminal liability.

Criminal sanctions are clearly defined under Georgian criminal law, and the state practice of ensuring transparency and public participation has served as a model for other countries. As a result of these reforms, corruption levels have significantly decreased, while trust in the public sector and standards of integrity have improved. Systematic monitoring and education have further strengthened public involvement and transparency in public administration, functioning as an additional preventive mechanism.

An independent and fair judicial system constitutes an essential component of Georgia's anti-corruption policy. Institutions responsible for monitoring public officials, verifying asset declarations, and ensuring compliance with ethical standards create an environment conducive to the effective implementation of criminal policy.

It is noteworthy that, under Article 5 of the Criminal Code of Georgia, Georgian citizens and stateless persons residing in Georgia who commit offenses such as commercial bribery (Article 221) or bribery (Articles 338–339) abroad are held criminally liable under Georgian law, even if such conduct does not constitute a crime under the legislation of the respective foreign state. This represents an exception to the principle of territoriality and highlights the global dimension and necessity of combating official misconduct.

The improvement of Georgian criminal legislation for the purpose of preventing official misconduct is of critical importance, as issues of corruption and transparency in public administration constitute an integral part of the country's democratic development. Although Georgia's judicial system and criminal legislation have been significantly strengthened in recent years, certain gaps still remain, the elimination of which would further enhance the effectiveness of the legal system and contribute to reducing corruption.

One of the primary recommendations concerns the clear and detailed definition of corruption-related offenses. While Georgian criminal law provides a general definition, there are still cases in which the classification of specific conduct as corrupt remains ambiguous. It is essential for legislation to be more precise and detailed in order to eliminate interpretative uncertainty. For example, notions such as "unjustified advantages" or "inducements" should be clearly defined to ensure uniform interpretation by courts and law enforcement authorities regarding what constitutes a corrupt act.

A second recommendation relates to the strengthening of control over the asset declarations of public officials. Although Georgia has actively worked to ensure transparency in this area, certain shortcomings remain. It is advisable to introduce a more effective and automated monitoring system that would prevent falsification or manipulation of declarations. Mechanisms such as asset audits and independent verification of submitted declarations would significantly contribute to greater transparency.

The strengthening of preventive measures is also of crucial importance. The objective of criminal policy is not only punishment but also prevention, aimed at avoiding the commission of offenses. Accordingly, legislation should more strictly regulate the conduct of public officials, including recruitment and entry procedures into public service. The development of criminal policy should also include strengthening ethical standards in public administration and improving training on official duties in order to prevent violations at an early stage.

The establishment of systemic anti-corruption investigative structures and the allocation of adequate resources to them is another important step. Strengthening Georgia's judicial and law enforcement institutions would contribute to a faster and more transparent response to corruption-related offenses. Such bodies should be granted greater authority and independence to ensure the effective conduct of investigations and enforcement of accountability mechanisms. For instance, the creation of specialized anti-corruption courts that deal exclusively with corruption cases would further enhance the effectiveness of the legal framework.

Another key recommendation is the strengthening of independence within both the public sector and the judiciary. Courts and law enforcement bodies must remain free from any political influence. This is essential to ensure impartial adjudication of corruption cases and timely delivery of judgments, thereby increasing public trust in the justice system. Further steps are required to

consolidate judicial independence and prevent any form of interference in legal proceedings.

The development of stricter sanctions is also an important aspect of reform. At present, Georgian criminal law is primarily focused on imprisonment, while alternative sanctions are less developed. Therefore, it is necessary to introduce a broader range of punitive and corrective measures tailored to different categories of public misconduct. Moreover, it is essential to clearly identify forms of systemic corruption that require particularly strict criminal sanctions.

Increasing public participation is another important recommendation. The success of criminal policy depends not only on state institutions but also on active civic engagement. Citizens should be more involved in public administration processes, particularly in monitoring the activities of public o officials and ensuring transparency. In addition, the integration of education on corruption and official misconduct into the education system is essential for raising public awareness.

In conclusion, the improvement of criminal policy in Georgia requires not only repressive measures but also a strong preventive approach. This includes enhancing the ethical and professional training of public officials, establishing strict transparency standards, and ensuring effective monitoring mechanisms. Through these combined measures, Georgia can more effectively combat official misconduct and further strengthen transparency in governance and democratic institutions.

Conclusion

Official misconduct constitutes one of the most serious challenges for any state, as it directly contradicts the public interest and undermines state authority as well as democratic governance. In the context of criminal law, the prevention and punishment of official misconduct not only ensure the restoration of justice but also contribute to maintaining a country's international credibility and trustworthiness.

The case of Georgia demonstrates that, despite significant steps taken over the past decade in combating corruption and official misconduct, the legal framework and institutional mechanisms are still not fully developed and require further improvement. Although current Georgian criminal legislation has achieved notable progress—such as the introduction of asset declaration systems for public officials and various anti-corruption measures—it still faces several fundamental challenges that hinder the effective prevention of official misconduct.

These challenges include the existence of overly general legal definitions, deficiencies in the monitoring of asset declarations, and potential issues related to the independence of the judiciary. Addressing these shortcomings represents an important step toward the further development and refinement of the system.

In addition, there is a need to strengthen criminal policy, which should focus not only on the detection and punishment of offenses but also on prevention and continuous monitoring. A more effective combination of repressive and preventive measures is necessary to ensure that society clearly understands that corrupt practices and official misconduct will be met with strict legal consequences, while the improvement of ethical and professional standards in public service becomes a prerequisite for national development.

In this process, a crucial role is played by the strengthening of the independence of legal institutions, including the judiciary and anti-corruption bodies, as well as by enhancing public oversight and encouraging citizen participation in governance processes. Only through such an approach can the rule of law be strengthened and responses to official misconduct become more effective and efficient.

Georgia has already demonstrated progress in this field; however, a renewed and more comprehensive legal framework is essential for further preventing official misconduct and reinforcing the rule of law. It is necessary for legislation to consistently maintain its focus on the protection of public interest and the improvement of legal standards. Only then will it be possible to achieve a systematic reduction of official misconduct and a significant strengthening of transparency in public administration.

References

1. Civil Georgia. (n.d.). *Anti-Corruption Commission Activities*. Retrieved from https://civil.ge

2. European Commission. (2020). *Rule of Law Report – Country Chapter on the Rule of Law Situation in Georgia*. Retrieved from https://commission.europa.eu

3. GRECO (Group of States against Corruption). (n.d.). *About GRECO*. Council of Europe. Retrieved from https://www.coe.int/en/web/greco

4. Human Rights Watch. (2023). *World Report 2023: Georgia – Section on Politicized Justice*.

5. OECD. (2020). *Anti-Corruption Reforms in Georgia: Fourth Round of Monitoring of the Istanbul Anti-Corruption Action Plan*.

6. Transparency International Georgia. (2022). *Corruption Perceptions Index and Assessments in Georgia*.

7. United Nations Office on Drugs and Crime (UNODC). (2004). *United Nations Convention against Corruption (UNCAC)*.

8. Gogoladze, M. (2019). *Problems of Legal Qualification of Certain Official Misconduct Offenses*.

9. Criminal Code of Georgia.

10. Criminal Code of Georgia, Article 70[1]. Legislative Herald of Georgia.

11. Criminal Code of Georgia, Article 338.

12. Law of Georgia on Public Service.

13. Lekveishvili, M. (2012). *Criminal Law – Special Part (Book II)*. Tbilisi.

14. Prosecutor's Office of Georgia. (2023). *Annual Report*. Retrieved from https://pog.gov.ge

THE LEGAL NATURE AND OPERATIONAL SPECIFICITIES OF DOCUMENTARY LETTERS OF CREDIT: CONTEMPORARY CHALLENGES AND WAYS FORWARD

Teona Giorgadze
PhD candidate,
Grigol Robakidze Universcity
Tbilisi
DOI: 10.5281/zenodo.20608602

Abstract

The documentary letter of credit constitutes a cornerstone of the international payment system and remains one of the most reliable settlement instruments in international trade. The reliability of the letter of credit is determined by its legal nature and operational mechanisms, which ensure the minimization of commercial and legal risks. Despite the impact of globalization, new economic models, and technological developments, the institution of the letter of credit has not lost its relevance.

This paper examines the legal nature of the documentary letter of credit and the specific features of its application. Particular emphasis is placed on the principles of autonomy and documentary compliance, which ensure legal predictability and reinforce trust among the parties involved.

The paper further emphasizes contemporary challenges affecting the functioning of letters of credit, including the digitalization of trade finance, compliance risks (defined in this paper as banks' adherence to international regulatory requirements, sanctions regimes and monitoring of financing rules), and sanctions-related restrictions. The compatibility of new economic models and regulatory frameworks with international standards governing letters of credit is also analyzed.

The article concludes that the continued relevance of documentary letters of credit depends on preserving their fundamental legal principles while adapting operational processes to contemporary technological and regulatory realities. The paper proposes several approaches aimed at addressing identified challenges and enhancing the efficiency and sustainability of letter-of-credit-based settlements.

Keywords: documentary letter of credit, international settlements, legal nature, operational framework, digitalization, compliance.

Introduction

International trade is fundamentally dependent on the availability of reliable and predictable settlement mechanisms. Within this framework, the documentary letter of credit occupies a particularly significant position. By integrating elements of private-law obligation with established banking practice, the letter of credit substantially reduces the risk of non-performance. This is especially significant in international trade, where legal systems and economic models differ across jurisdictions.

A comprehensive analysis of the legal nature, operational specifics and contemporary challenges of letters of credit is therefore highly relevant. The purpose of this article is to identify the key features of the legal regulation of letters of credit and to substantiate the need for their adaptation to modern challenges while preserving their fundamental principles.

Research Methodology

This research is conducted using comparative analysis method, based on a review of practical publications in the field of international settlements, banking practice, systematic descriptions of banking operations, international standards (UCP 600) and other legal sources.

The Concept and Legal Nature of the Documentary Letter of Credit

The documentary letter of credit is a complex financial and legal instrument widely used in international trade to ensure secure settlements. It constitutes a written undertaking by the issuing bank, given at the request of the buyer, to pay a specified amount to the seller within a defined period, provided that the agreed conditions between the buyer and the seller are fulfilled. The basis for payment is the presentation by the seller of documents that comply with the terms and conditions stipulated in the letter of credit (Alavi, 2016).

The principal normative framework governing documentary letters of credit is the *Uniform Customs and Practice for Documentary Credits (UCP 600)*, which establishes internationally recognized rules and standards for their application and functions as a benchmark of global banking practice (O'Shea, 2007).

Developed by the International Chamber of Commerce (ICC), UCP 600 aims to harmonize letter of credit operations in international trade. Comprising 39 articles, it regulates all stages of the credit operation, including definitional provisions and rules governing banks' examination of documents (UCP 600, 2007).

A defining feature of the documentary letter of credit is its autonomous legal nature. Under international banking practice, the letter of credit constitutes an independent obligation of the issuing bank, legally distinct from the underlying sales or commercial contract (O'Shea, 2007).

This principle in international law means that a bank which has issued a letter of credit at the request of its client is obliged to effect payment solely on the basis of the presentation of the documents specified in the text of the letter of credit, irrespective of the existence of any dispute between the parties to the transaction that

may arise from the non-performance or improper performance of the underlying contract. This approach reduces legal risk and enhances the reliability of settlements (O'Shea, 2007).

Operational Characteristics of Documentary Letters of Credit

The operational framework of documentary letters of credit is grounded in the principle of documentary examination. Banks are required to assess only whether the presented documents comply with the terms of the credit and with the requirements of UCP 600, without regard to the actual condition, quality, or existence of the goods or services concerned (UCP 600, Art. 14).

This approach ensures efficiency and speed in settlements while reducing banks' operational burdens. At the same time, it requires a high level of professional competence among bank staff, as even minor discrepancies in documents may serve as grounds for refusal of payment (LegalClarity, 2025).

Contemporary Challenges in the Use of Documentary Letters of Credit

Digitalization of Trade Finance

The digital transformation of trade finance has significantly challenged the traditional, paper-based model of documentary letters of credit. Historically reliant on physical documentation, the instrument now operates within an environment increasingly shaped by electronic document exchange, digital trade platforms and distributed registries. The ICC has acknowledged that the absence of universally accepted digital standards constitutes a major impediment to the modernization of trade finance (ICC, 2020).

Despite the introduction of the eUCP (Electronic Uniform Customs and Practice) as a supplement to UCP 600, the practical use of electronic documents remains fragmented, as the legal status of electronic documents depends on national legislation and the consent of all parties involved in the letter of credit transaction. This creates legal uncertainty, while the complete digitalization of operations may reduce trust in transactions (ICC, 2023).

Compliance Risks and Sanctions Regimes

In the modern era, banks engaged in documentary letter of credit transactions increasingly face enhanced compliance requirements, sanctions regimes, anti-money laundering (AML) procedures, and "know your customer" (KYC) obligations. Banks are required to verify not only documents but also the identities and activities of clients, significantly complicating the operational model of letters of credit (Basel Committee on Banking Supervision, 2014).

Compliance with international sanctions regimes and regulatory requirements may create tension between the autonomy of the letter of credit and banks' legal obligations. In some cases, banks suspend or refuse payments under letters of credit not due to documentary discrepancies, but for compliance-related reasons, thereby transforming the traditional legal nature of the instrument (ICC, 2022).

Harmonization of International Standards and Legal Fragmentation

A persistent challenge in letter of credit practice is the incomplete harmonization between ICC rules and national legal systems. Although UCP 600 is widely incorporated into international practice, it does not possess the status of an international treaty and applies only where expressly referenced in the credit (UCP 600, 2007).

Divergent national approaches to the legal recognition of electronic documents and digital signatures further hinder the development of a universally applicable digital letter of credit. In this regard, UNCITRAL emphasizes the necessity of recognizing electronically transferable records to ensure the effective functioning of digital trade instruments (UNCITRAL, 2017).

Institutional and Operational Implications of Contemporary Challenges

Contemporary regulatory and technological developments have transformed the role of banks in letter of credit operations. Banks increasingly function not merely as payment intermediaries but as active risk managers, a role that strengthens internal controls while simultaneously increasing operational costs and processing time (Bank for International Settlements, 2014).

These transformations affect international trade. International organizations emphasize that trade finance is a key pillar of global trade stability, as approximately 80–90% of world trade depends on it (World Trade Organization, n.d.). New challenges may limit access to letters of credit and similar instruments, particularly in countries with developing financial sectors.

Conclusion

Despite significant contemporary challenges, the documentary letter of credit remains one of the most reliable instruments of international settlement, offering a high degree of legal certainty and effective mitigation of commercial risk. Its enduring relevance is rooted in its autonomous legal structure and documentary character, which enable predictable and efficient settlement independent of the underlying contract.

The autonomy and formalism of the letter of credit should not be viewed as shortcomings, but rather as mechanisms protecting the parties to the transaction. Independence from the underlying contract enables predictability of legal outcomes and minimizes the emergence of commercial disputes.

The operational specifics of letters of credit are reflected in the distribution of responsibilities among transaction participants and banks. While this model ensures efficiency and speed, it remains sensitive to technical discrepancies and errors in documentation, underscoring the need for continuous improvement of banking practices and professional training.

Among contemporary challenges, the digitalization of international trade calls into question traditional document-based processes and necessitates legal and operational adaptation, including the introduction of standards for electronic documentation. Despite international efforts, digital transformation is accompanied

by legal uncertainty, particularly concerning the recognition of electronic documents and digital signatures across jurisdictions.

Compliance risks and sanctions restrictions represent another significant challenge, substantially altering the traditional model of letters of credit. New regulations require banks to consider not only the terms of the credit but also sanctions regimes and regulatory requirements, which may ultimately reduce the volume of settlements conducted through letters of credit.

The harmonization of international rules and national legislation remains crucial. Unified rules and their continuous adaptation form the foundation of international banking practice and must respond to contemporary economic and technological realities. Particular importance is attached to aligning contractual standards related to sanctions, digital technologies, and financial security with private law norms.

Overall, this research demonstrates that addressing the identified challenges requires the development of unified international digital standards, expanded use and legal recognition of electronic documents, and strengthened institutional cooperation among banks, regulators, and international organizations.

Despite the transformation of international trade and financial markets, the documentary letter of credit has not lost its relevance. It is essential that its future development be grounded in fundamental legal principles, while considering the requirements of the digital economy and global regulatory frameworks. Such an approach within the contemporary system of international trade ensures the sustainability and effectiveness of the documentary letter of credit as an instrument of international settlement.

References

1. Alavi, H. (2016). *Documentary Letters of Credit, Legal Nature and Sources of Law.* Jurnal of Legal Studies, 17(31). Website:

https://sciendo.com/2/v2/download/article/10.1515/jles-2016-0012.pdf

2. O'Shea, P. (2007). Legal and Practice Perspectives on Docuemntary Credits under UCP 600. Website:

https://www.academia.edu/9111965/Legal_and_Practice_Perspectives_on_Documentary_Credits_Under_UCP_600?sm=b

3. ICC. (2007). *Uniform Customs and Practice for Documentary Credits (UCP 600)* Website:

http://static.elmercurio.cl/Documentos/Campo/2011/09/06/2011090611422.pdf

4. International Chamber of Commerce. (2020). *ICC Digital Standards Initiative.* Website:

https://iccwbo.org/news-publications/news/icc-digital-standards-initiative-launches-complete-framework-for-supply-chain-digitalisation/

5. International Chamber of Commerce. (2023). eUCP Version 2.1. Website:

https://iccwbo.org/news-publications/policies-reports/eucp-version-2-1-icc-uniform-customs-and-practice-for-documentary-credits/

6. Basel Committee on Banking Supervision. (2014). *Trade finance: Developments and issues.* Website:

https://www.bis.org/publ/cgfs50.htm

7. International Chamber of Commerce. (2022). *Consolidated ICC guidance on the use of sanctions clauses in trade finance-related instruments sunject to ICC rules.* Website:

https://iccwbo.org/news-publications/policies-reports/consolidated-icc-guidance-on-the-use-of-sanctions-clauses-in-trade-finance-related-instruments-subject-to-icc-rules/?utm

8. UNCITRAL. (2017). *Model Law on Electronic Transferable Records.* Website:

https://uncitral.un.org/en/texts/ecommerce/modellaw/electronic_transferable_records

9. World Trade Organization. (n.d.). *Trade Finance.* Website:

https://www.wto.org/english/thewto_e/coher_e/tr_finance_e.htm?utm

PEDAGOGICAL SCIENCES

THE INTRODUCTION OF BLENDED LEARNING TECHNOLOGIES INTO RUSSIAN LANGUAGE TEACHING (USING THE LEARNINGAPPS.ORG PLATFORM AS AN EXAMPLE)

Lola Salimbekovna Gafarova
Head of the Department of Russian Language and Literature, NamGIYA, Namangan, Uzbekistan
DOI: 10.5281/zenodo.20609175

ВНЕДРЕНИЕ ТЕХНОЛОГИЙ СМЕШАННОГО ОБУЧЕНИЯ В ПРЕПОДАВАНИЕ РУССКОГО ЯЗЫКА (НА ПРИМЕРЕ ПЛАТФОРМЫ LEARNINGAPPS.ORG)

Гафарова Лола Салимбековна
заведующий кафедрой русского языка и литературы НамГИИЯ, г. Наманган Узбекистан

Abstract

This article examines the use of blended learning in Russian language teaching. It demonstrates that combining traditional classroom sessions with digital resources makes the learning process more flexible and engaging. Particular attention is paid to the LearningApps.org platform, which helps to create interactive tasks and integrate them seamlessly into lessons. It is concluded that such services enhance the teacher's capabilities and meet the needs of modern education.

Аннотация

В статье рассматривается применение смешанного обучения в преподавании русского языка. Показано, что сочетание традиционных занятий и цифровых ресурсов позволяет сделать учебный процесс более гибким и мотивирующим. Особое внимание уделяется платформе LearningApps.org, которая помогает создавать интерактивные задания и органично интегрировать их в урок. Делается вывод, что такие сервисы усиливают возможности педагога и отвечают потребностям современного образования.

Keywords: Blended learning, digital learning environment, teaching Russian, online platforms, interactive activities, LearningApps.org.

Ключевые слова: Смешанное обучение, цифровая образовательная среда, преподавание русского языка, онлайн-платформы, интерактивные задания, LearningApps.org.

Современное образование развивается в условиях стремительной и всеобъемлющей цифровизации. Уже невозможно представить учебный процесс, ограниченный исключительно традиционной формой: наряду с классическими учебными пособиями и классной доской активно используются электронные ресурсы, онлайн-платформы и интерактивные сервисы. Данные изменения обусловлены не только техническим прогрессом, но и сменой образовательных потребностей обучающихся, которые привыкли к цифровой среде и ожидают, что обучение будет строиться с учётом этой новой реальности.

Одним из наиболее перспективных и методологически обоснованных форматов является смешанное обучение. Оно представляет собой интеграцию очных занятий с цифровыми ресурсами, что позволяет объединить преимущества двух моделей: живое взаимодействие с преподавателем и гибкость онлайн-обучения. Такой формат даёт возможность учитывать индивидуальные темпы работы, повышает мотивацию и делает образовательный процесс более открытым и динамичным [4, С. 85].

Смешанное обучение строится на идее интеграции. В аудитории остаётся то, что невозможно заменить никакими технологиями: живой диалог, обсуждение, коллективная работа, эмоциональный контакт с преподавателем. В цифровой среде учащиеся получают доступ к интерактивным заданиям, тестам, мультимедийным материалам, которые помогают закрепить знания и расширить опыт обучения [6, С. 563]. Однако развитие технологий идёт настолько быстро, что педагогическая теория не всегда успевает предложить готовые методические модели. На практике именно учителя становятся первыми исследователями: они внедряют новые сервисы, экспериментируют, ищут оптимальные формы их применения. Этот процесс показывает, что смешанное обучение формируется «снизу», через реальное использование цифровых ресурсов, а затем получает научное осмысление [5, С. 138].

В преподавании русского языка такая модель особенно важна. Русский язык требует как устного общения и совместного анализа текстов, так и систематической тренировки правил. Смешанное обучение позволяет соединить эти задачи: дискуссия и объяснение проходят в аудитории, а закрепление и проверка материала — в цифровой среде [1, С. 78].

Современные школы и вузы всё чаще используют дистанционные и цифровые инструменты для поддержки традиционных уроков. Практика показывает, что такие ресурсы позволяют разнообразить занятия, включить игровые элементы и стиму-

лировать самостоятельную работу студентов. Вместе с тем отмечаются и трудности: необходима техническая база и цифровая грамотность всех участников процесса [2, С. 33]. Главным результатом внедрения технологий становится изменение роли преподавателя. Он перестаёт быть только источником информации и всё больше выступает как организатор образовательного процесса, направляющий студента и помогающий ему использовать ресурсы онлайн-среды для достижения личных целей обучения.

Особое внимание заслуживает платформа LearningApps.org, которая зарекомендовала себя как удобный инструмент для создания интерактивных заданий. Она проста в использовании: педагог выбирает шаблон и наполняет его собственным материалом. Платформа предлагает десятки форматов: тесты, карточки, классификации, кроссворды, задания на установление соответствия, временные шкалы, интерактивные игры.

(Рис. 1. Главная страница платформы LearningApps.org)

Для преподавания русского языка LearningApps.org предоставляет богатые возможности. С её помощью можно:

– создавать упражнения для закрепления орфографии и пунктуации;

– расширять словарный запас с помощью карточек и классификаций;

– анализировать литературные произведения через кроссворды и тесты;

– тренировать навыки морфологического и синтаксического разбора;

– разрабатывать задания для развития коммуникативной и культурной компетенции.

Платформа эффективна как для аудиторной, так и для самостоятельной работы. В классе задания можно выполнять совместно и обсуждать результаты, а дома — проходить их индивидуально, в удобном темпе. Таким образом, LearningApps обеспечивает непрерывность образовательного процесса: то, что сделано онлайн, становится частью следующего урока офлайн.

(Рис. 2. Пример задания по русскому языку, созданного в LearningApps.org)

Важным преимуществом является возможность обмена заданиями: учителя делятся разработками, студенты могут повторять упражнения неоднократно. Это превращает LearningApps.org не просто в инструмент, а в элемент целостной образовательной среды, которая поддерживает ценности открытости и гибкости.

В условиях смешанного обучения LearningApps.org выполняет сразу несколько функций. Во-первых, это инструмент для самостоятельной работы учащихся: они могут выполнять задания в удобном темпе, возвращаться к материалу и закреплять знания. Во-вторых, это ресурс для организации аудиторной активности: учитель может вывести задание на экран и предложить группе выполнить его совместно, обсуждая результаты. В-третьих, платформа служит каналом обратной связи, поскольку результаты выполнения позволяют увидеть, какие темы вызывают трудности.

Таким образом, LearningApps.org можно рассматривать как современный методический ресурс, органично интегрирующийся в модель смешанного обучения. Он помогает сделать уроки русского языка динамичнее, разнообразнее и ближе к цифровой культуре учащихся, при этом сохраняя главную ценность традиционной педагогики — живое взаимодействие учителя и студента.

Использованная литература

1. Ефремкова И. В. К вопросу внедрения информационных технологий в образовательную практику учреждений образования // Образование 21 века: тренды, новые модели эпохи цифровизации и провайдеры поколения NEXT. – 2021. – С. 133.

2. Ибатуллина А. И., Старцева О. Г. Применение средств дистанционных образовательных технологий для обучения школьников // Дистанционное образование: проблемы, опыт, перспективы. – 2022. – С. 116.

3. Игнатович Т. В. Обучение русскому языку как иностранному с использованием сервиса LearningApps // Русистика. – 2021. – С. 51–65.

4. Полат Е. С. Теория и практика дистанционного обучения: учеб. Пособие для студ. высш. пед. учеб. заведений. – М.: Академия, 2004. – С. 416.

5. Хуторской А. В. Интернет-практика обгоняет педагогическую теорию // Эйдос. – 2000. – URL: https://eidos.ru/journal/2000/0523.htm

6. Яковлева О. В. Модель ценностей цифровой образовательной среды как ориентир профессионального воспитания будущих учителей // Педагогика. Вопросы теории и практики. – 2023. – № 5. – С. 561-568.

THE PSYCHOLINGUISTIC NATURE OF ORAL SPEECH ACTIVITY AND ITS PEDAGOGICAL INTERPRETATION

Atamirzayeva Ezoza Bekmirzayevna
PhD, Associate Professor at the Iskhakkhan Ibrat Namangan State Institute of Foreign Languages
DOI: 10.5281/zenodo.20609250

Abstract
This article examines the psychological and methodological foundations of oral speech activity in foreign language teaching. The study highlights the close relationship between methodology and psychology, emphasizing that the effectiveness of language learning largely depends on learners' psychological readiness, motivation, memory, attention, and communicative autonomy. The paper analyzes the concepts of knowledge, skills, habits, and competences, as well as their role in the development of oral speech. Special attention is given to the transformation of theoretical linguistic knowledge into practical communicative skills through systematic exercises and real-life communicative practice.

Keywords: oral speech activity, psycholinguistics, foreign language teaching, communicative competence, knowledge, skills, habits, competence, methodology, memory, attention, speech development, communicative environment, language acquisition.

Introduction. Methodology and psychology are closely interconnected disciplines, and the effectiveness of foreign language teaching largely depends on the learner's psychological state, motivation, autonomy, and the creation of a free communicative environment. Therefore, considering psychological factors has become one of the essential methodological principles in modern foreign language teaching. For foreign language teaching methodology, it is of great importance to understand psychological processes such as thinking, memory, and perception, as well as psychological concepts including knowledge, skills, and habits, their nature, and the ways in which they are formed and developed. This is because one of the primary objectives of methodology is to develop learners' speech skills and communicative abilities. Understanding the concepts of knowledge, skills, and habits, together with their interrelationship, plays a significant role in comprehending the psychological foundations of foreign language education. Below, the essence of these concepts is discussed.The concept of knowledge is one of the most frequently used notions in everyday life. However, it is not always easy to clearly distinguish between the concepts of "knowledge," "science," and "scientificity." Knowledge refers to the scientific experience, concepts, and information acquired by an individual in a particular field. For example:

1. linguistic knowledge;
2. grammatical knowledge;
3. phonetic knowledge;
4. lexical knowledge;
5. language-related knowledge.

In the process of language education, such theoretical knowledge should be transformed into practical skills through active practice. According to Lev Vygotsky, knowledge develops effectively through social interaction and practical activity, while learning becomes meaningful when theory is applied in communication [6, 89]. A skill is understood as a consciously performed action or operation. Knowledge is transformed into skills through exercises and repeated practice. For instance, knowing the rules for forming plural nouns in French or English represents grammatical knowledge, whereas the ability to apply these rules correctly in actual speech constitutes a grammatical skill. Thus, a skill can be defined as the conscious application of theoretical knowledge in practical activity. Through systematic practice, skills gradually develop and reach the level of habit or competence.A habit or competence refers to partially automatized skills. Examples include:

a) listening comprehension skills;
b) speaking skills;
c) reading skills;
d) writing skills.

Such competences are formed and developed through purposeful and systematic exercises. In this regard, B. F. Skinner [7, 27] emphasized that repeated practice and reinforcement play a decisive role in the automatization of skills and the formation of stable habits. Similarly, Jean Piaget [5, 39] highlighted that learning develops progressively from conscious understanding to automatic performance through continuous cognitive activity.In the educational process, high results can be achieved through the following sequence:

knowledge → practice → skill → practice → competence → practice → mastery.

This system constitutes the psychological and methodological foundation of the foreign language learning process.Methodologist R. Zaripova also emphasizes the significant role of knowledge, skills, and competences in foreign language teaching. According to the scholar, general knowledge refers to the information acquired by an individual about nature and society through the process of cognition, and it can be divided into two categories:

1. Knowledge related to language material itself;
2. Knowledge related to activities performed through language material. [4, 12]

The first category includes knowledge of phonetic, grammatical, and lexical materials, whereas the second category involves the ways of applying these materials in practical speech activity.In the process of foreign language teaching, transforming theoretical knowledge into practical skills and competences is considered one

of the main methodological objectives. Therefore, modern methodology pays special attention to exercises and practical activities. Speech activities are carried out on the basis of language material, which ultimately leads to the formation of speech competences. Knowledge, skills, and competences play a fundamental role in the development of oral speech. If a learner does not possess sufficient grammatical, lexical, and phonetic knowledge of the target language, he or she will be unable to construct grammatically correct utterances. Moreover, the incorrect use of words may result in misunderstanding and misinterpretation of the speaker's ideas. Deficiencies in pronunciation may also prevent the listener from fully understanding the speaker's message.For this reason, teachers should pay particular attention to transforming students' theoretical knowledge into practical skills through various exercises during the teaching process. It is equally important to create opportunities for learners to apply the acquired skills in real communicative situations. Speech-related skills are gradually developed through systematic exercises and practical activities and eventually reach the level of competence or mastery.

Memory is a psychological process through which individuals retain objects, phenomena, and past experiences reflected in human consciousness and reproduce them when necessary. It is one of the essential characteristics of the nervous system and manifests itself in the ability to preserve information about external events and the organism's reactions for a long period of time, as well as to retrieve this information in the process of conscious activity and behavior. Memory plays a crucial role in the process of speaking. If memory is not sufficiently developed, words and phrases within an utterance may fail to connect grammatically and logically.When expressing ideas orally in French, learners rely on their phonetic, lexical, and grammatical knowledge. In other words, grammatical rules of French, verb conjugations, article usage, word order, and speech patterns are stored in their memory.For example:

Il a pris le médicament. — "He took the medicine."

In this example, the learner correctly recalls from memory that the noun *médicament* ("medicine") is commonly used with the expression *prendre un médicament* ("to take medicine"), rather than with the verb *boire* ("to drink"). The learner also correctly applies the verb *prendre* in the *passé composé* tense with the auxiliary verb *avoir*. Alongside memory, attention also plays a significant role in oral speech production. Only when the speaker's attention is properly concentrated can he or she convey ideas clearly and understandably to the listener.

Attention is the orientation of an individual's activity toward a particular object or phenomenon. It is considered an essential condition for the effectiveness of any conscious activity. The physiological basis of attention lies in the optimal excitation centers located in certain areas of the cerebral cortex. According to I. Zimnyaya, the stability of attention and speech motivation are among the most important psychological factors contributing to the successful realization of oral speech activity [2, 46]. Another important psychological mechanism involved in the speaking process is prediction.

Prediction .In speech activity, prediction enables the listener or speaker to anticipate the continuation of an idea, understand the content of speech more quickly, and respond appropriately to the communicative situation. For example:

— *Qu'est-ce que tu vas faire demain ?* ("What are you going to do tomorrow?")

Upon hearing this question, the learner can predict in advance that the following topic will be related to plans or future activities.The speaking process becomes effective only when psychological mechanisms such as memory, attention, and prediction function in harmony with one another. Therefore, taking these psychological factors into account in the teaching of French is of great methodological importance for the development of oral speech competence.The study of psychologists' views on speech formation makes it possible to conclude that speaking activity is influenced by various motives and needs. Internal factors that encourage a person to communicate play a significant role in the emergence of speech activity. I. Zimnyaya classifies the motives stimulating speaking into three groups:

1. Spiritual and cognitive motives;
2. Moral motives;
3. Emotional and aesthetic motives [2, 47].

These motives are associated with an individual's desire to acquire new knowledge, broaden one's worldview, and learn about the language and culture of other nations. The success of teaching speaking in a foreign language largely depends on the strength, regularity, and stability of these motives, as well as on the learner's internal needs and interests.Therefore, in teaching French, it is of great methodological importance to develop students' communicative motivation and to use topics and communicative situations that are emotionally engaging and stimulating for learners.

References

1. Zhinkin, N.I. Speech as a Means of Information Transmission. Moscow: Nauka Publishers, 1982. 159 p.
2. Zimnyaya, I.A. Psychology of Foreign Language Teaching at School. Moscow: Prosveshcheniye Publishers, 1991. 222 p.
3. Leontiev, A.N. Activity. Consciousness. Personality. Moscow: Politizdat Publishers, 1975. 304 p.
4. Zaripova, R.A. A Manual on Foreign Language Teaching Methodology. Tashkent, 1986.
5. J Piaget, J. The Psychology of Intelligence. London: Routledge, 1950.
6. Vygotsky, L.S. Thought and Language. Cambridge, MA: MIT Press, 1986.
7. Skinner, B. F. The Technology of Teaching. — New York: Appleton-Century-Crofts, 1968. — 271 p.

PHILOLOGICAL SCIENCES

HOW COGNITIVE LINGUISTICS CAN HELP VOCABULARY TEACHING

Roya Zeynalova
Nakhchivan State University, Teacher
https://orcid.org/0009-0004-8712-7975
DOI: 10.5281/zenodo.20609408

Abstract

This article examines how Cognitive Linguistics can contribute to vocabulary teaching from both theoretical and pedagogical perspectives. It focuses on major concepts such as categorization, prototype theory, polysemy, image schemas, conceptual metaphor, and usage-based learning, and explains how these concepts can support more effective lexical instruction. In many traditional classrooms, vocabulary is often taught through memorization, translation, and isolated word lists. Although such methods may help short-term recall, they do not always enable learners to understand semantic relations among words or recognize how meanings develop in different contexts. Cognitive Linguistics offers an alternative perspective by explaining lexical meaning as motivated, interconnected, and grounded in human experience.The article particularly highlights the usefulness of cognitive linguistic approaches in teaching polysemous words, prepositions, idioms, phrasal verbs, and figurative language. It argues that vocabulary learning becomes more meaningful when learners recognize conceptual patterns behind lexical usage and understand semantic connections among meanings. In addition, the article discusses the pedagogical value of presenting vocabulary through authentic contexts and usage patterns rather than as isolated forms. At the same time, the effectiveness of this approach depends on teacher expertise, suitable materials, and adaptation to classroom needs. Overall, the article concludes that Cognitive Linguistics provides a valuable framework for making vocabulary teaching more systematic, coherent, memorable, and learner-centered.

Keywords: Cognitive Linguistics, vocabulary teaching, polysemy, conceptual metaphor, lexical learning.

Introduction

Vocabulary plays a fundamental role in language learning because successful communication depends largely on lexical knowledge. Even when learners have a good understanding of grammar, communication may still fail if they do not know enough words or cannot use them appropriately in context. For this reason, vocabulary teaching has always been considered one of the most important components of foreign language education. However, in many traditional classrooms vocabulary instruction is still based on memorization techniques such as learning word lists, translating isolated lexical items, or matching words with dictionary definitions. Although these methods may support short-term recall, they often fail to help learners develop a deeper understanding of how words function, how meanings are interconnected, and how lexical knowledge expands through usage and context.

Cognitive Linguistics offers an alternative perspective on vocabulary teaching because it views language as closely connected with human cognition, bodily experience, and conceptualization. Unlike traditional structural approaches that frequently treat meaning as arbitrary, Cognitive Linguistics explains lexical meaning as motivated and systematic (Lakoff, 1987; Langacker, 2008). From this perspective, words are not isolated units stored separately in memory; instead, they form semantic networks that are connected through experience, categorization, metaphorical thinking, and contextual usage. This perspective can make vocabulary learning more meaningful because learners are encouraged to recognize conceptual relations among lexical items rather than memorize unrelated forms (Nuri, 2025).

This perspective is particularly important in second-language learning because many lexical difficulties are related to polysemy, figurative meaning, prepositions, idioms, and phrasal verbs. Learners often find these areas confusing because the same word may carry multiple meanings depending on context. Cognitive Linguistics attempts to explain these semantic extensions systematically rather than presenting them as random exceptions. Recent research also demonstrates that cognitively inspired language teaching has become an important and growing field within applied linguistics (Qin, Liu, & Lei, 2024, pp. 478–480). Scholars increasingly argue that cognitive explanations can improve learner comprehension, retention, and inferencing skills by making vocabulary instruction conceptually clearer and psychologically more realistic.The purpose of this article is to examine how Cognitive Linguistics can contribute to vocabulary teaching from a theoretical and pedagogical perspective. The article focuses especially on concepts such as categorization, prototype theory, polysemy, image schemas, conceptual metaphor, and usage-based learning. It also discusses the advantages and possible limitations of applying cognitive linguistic principles in language classrooms. Overall, the article argues that Cognitive Linguistics can make vocabulary teaching more systematic, coherent, and memorable by helping learners understand not only what words mean, but also why they develop particular meanings and how those meanings are interconnected.

Research

Cognitive Linguistics is particularly valuable for vocabulary teaching because it places meaning at the center of language analysis. Rather than viewing language as an autonomous system separated from general cognition, it assumes that linguistic meaning reflects

human perception, bodily experience, conceptualization, and categorization (Evans & Green, 2006). In this framework, vocabulary learning is not simply the memorization of lexical items but the gradual development of conceptual understanding. Learners are encouraged to see how meanings are interconnected and how language reflects human interaction with the world.

One of the most influential contributions of Cognitive Linguistics to vocabulary teaching is its explanation of categorization and prototype effects. Traditional approaches often imply that categories are rigid and that each lexical item has a fixed meaning. However, Cognitive Linguistics argues that categories are usually organized around prototypical members, while other members occupy more peripheral positions (Lakoff, 1987, pp. 68–76). For example, when learners think of the category "bird," they are more likely to imagine a robin or sparrow than a penguin or ostrich. This demonstrates that category membership is graded rather than absolute. In vocabulary teaching, such insights can help learners understand why some examples appear more natural or typical than others.

Closely connected with categorization is the issue of polysemy, which is one of the greatest challenges in vocabulary learning. Many English words have multiple related meanings, and learners often struggle to understand how these senses are connected. Traditional vocabulary instruction frequently teaches these meanings separately, presenting them as unrelated definitions that must simply be memorized. Cognitive Linguistics offers a more systematic explanation by showing that polysemous meanings are usually organized around a central sense from which other meanings develop through semantic extension (Tyler, 2012, pp. 79–84). This approach is especially effective in teaching prepositions, particles, and phrasal verbs. Tyler and Evans (2003, pp. 1–5) argue that English prepositions are structured semantic networks grounded in spatial experience rather than arbitrary collections of meanings. For example, the preposition *over* may first refer to physical position ("The lamp is over the table") and later extend metaphorically into meanings such as control or superiority ("She has authority over the team").

Another important concept in Cognitive Linguistics is the notion of image schemas. Image schemas are recurring embodied patterns derived from physical and sensory experience, including containment, movement, balance, force, and path (Evans & Green, 2006; Tyler & Evans, 2003). These schemas structure many abstract meanings in language. For example, the containment schema helps explain expressions such as "in trouble," "out of danger," or "fall into depression." Although these expressions describe abstract situations, they are conceptualized through spatial experience. In vocabulary teaching, image schemas provide learners with conceptual support by explaining why certain figurative meanings exist.

Conceptual metaphor theory is another major contribution of Cognitive Linguistics to vocabulary teaching. According to Lakoff (1987), metaphor is not simply a stylistic feature of literary language but a fundamental mechanism of human thought. People commonly understand abstract concepts through more concrete experiences. For example, time is often conceptualized as movement ("The weekend is approaching"), and emotions may be conceptualized spatially ("She is feeling down"). Such metaphorical patterns are deeply embedded in everyday language and academic discourse. The pedagogical usefulness of conceptual metaphor becomes especially clear in the teaching of idioms and phrasal verbs. These lexical areas are often regarded by learners as highly irregular and difficult because traditional instruction frequently presents them as arbitrary combinations. Cognitive Linguistics, however, attempts to uncover the conceptual logic behind such expressions. Yasuda (2010, pp. 250–252) demonstrated that Japanese EFL learners improved their understanding of phrasal verbs when they were taught through conceptual metaphor rather than through conventional explanation alone. Similarly, Boers (2013, pp. 208–210) argues that cognitive linguistic approaches can make vocabulary and phraseology more teachable by highlighting semantic motivation.Another important contribution of Cognitive Linguistics is its usage-based approach to language. According to this perspective, linguistic knowledge develops gradually through repeated exposure to meaningful language use rather than through abstract grammatical rules alone (Langacker, 2008; Tyler, 2012). This principle has significant implications for vocabulary teaching because it encourages instruction based on authentic patterns of usage, collocations, and constructions. Words are therefore taught not as isolated units but as parts of larger contextual structures. Such exposure supports richer lexical knowledge, better retention, and more natural language production.Despite its many advantages, Cognitive Linguistics should not be viewed as a complete solution to all vocabulary-teaching problems. The effectiveness of this approach depends largely on how successfully theoretical insights are adapted into practical classroom instruction (Zeynalova, 2025). If cognitive explanations become overly technical or abstract, learners may feel overwhelmed rather than supported. Consequently, teachers must carefully select appropriate concepts and adjust explanations according to learner level, educational goals, and classroom context (Qin et al., 2024, pp. 491–495).

Overall, Cognitive Linguistics provides a powerful framework for vocabulary teaching because it explains why words mean what they mean, how meanings develop, and how lexical items are interconnected. By presenting vocabulary as a motivated semantic system rather than a random collection of forms, it encourages learners to engage with language more deeply and meaningfully.

Conclusion

Cognitive Linguistics provides an important framework for vocabulary teaching by explaining lexical meaning as motivated, interconnected, and grounded in human cognition and experience. Unlike traditional approaches that rely mainly on memorization and translation, cognitive linguistic approaches encourage learners to understand how meanings are conceptually related and how lexical items develop through categorization, semantic extension, metaphorical thinking, and contextual usage.The discussion in this article has shown that concepts such as prototype

theory, polysemy, conceptual metaphor, image schemas, and usage-based learning have important pedagogical value. These concepts are especially useful in teaching lexical areas that learners often find difficult, including prepositions, idioms, phrasal verbs, and figurative expressions. By recognizing semantic patterns and conceptual motivation, learners may improve comprehension, retention, and communicative competence.At the same time, the successful application of Cognitive Linguistics depends on teacher expertise, appropriate materials, and adaptation to learner needs.

Overall, Cognitive Linguistics can make vocabulary teaching more meaningful, systematic, and memorable by helping learners understand not only what words mean, but also how meanings are connected within the language system.

References

1. Boers, F. (2013). *Cognitive linguistic approaches to teaching vocabulary: Assessment and integration*. *Language Teaching, 46*(2), 208–224. https://doi.org/10.1017/S0261444811000450

2. Boers, F., & Lindstromberg, S. (Eds.). (2008). *Cognitive linguistic approaches to teaching vocabulary and phraseology*. Mouton de Gruyter.

3. Evans, V., & Green, M. (2006). *Cognitive Linguistics: An Introduction*. Edinburgh University Press.

4. Zeynalova, R. (2025). Language Assessment in Instructional Contexts: Design Considerations and Practical Insights. *Porta Universorum*, *1*(7), 12-19. https://doi.org/10.69760/portuni.0107002

5. Lakoff, G. (1987). *Women, Fire, and Dangerous Things: What Categories Reveal about the Mind*. University of Chicago Press.

6. Nuri, A. B. (2025). Cognitive Linguistics as Language Education: Advancing Meaning-Making, Conceptual Understanding, and Learner-Centered Pedagogy.

7. Langacker, R. W. (2008). *Cognitive Grammar: A Basic Introduction*. Oxford University Press.

8. Littlemore, J., & Low, G. (2006). Metaphoric competence, second language learning and communicative language ability. *Applied Linguistics, 27*(2), 268–294. https://doi.org/10.1093/applin/aml004

9. Qin, J., Liu, D., & Lei, L. (2024). Cognitive linguistics-inspired language instruction. *Language Teaching, 57*(4), 478–500. https://doi.org/10.1017/S0261444824000119

10. Tyler, A. (2012). *Cognitive Linguistics and Second Language Learning: Theoretical Basics and Experimental Evidence*. Routledge.

11. Yasuda, S. (2010). Learning phrasal verbs through conceptual metaphors: A case of Japanese EFL learners. *TESOL Quarterly, 44*(2), 250–273. https://doi.org/10.5054/tq.2010.219945

THE RESTORATION OF ARCHETYPAL MEMORY IN THE CREATIVE WORK OF ISA MUGHANNA

Alı Hashımov
The chair of "Azerbaijani literature", Nakhchivan State University
Doctor of philosophy in philology, associate professor
ORCID 0009-0005-7069-9202
Anar Abuzarli
Nakhchivan State University
PhD in Philology
ORCID 0009-0007-6574-2725
DOI: 10.5281/zenodo.20609472

Abstract

This article examines the problem of the restoration of archetypal memory in the creative work of Isa Mughanna from psychoanalytic and mythopoetic perspectives. The study focuses on the writer's novellas *"Saz," "Telegram," "Kollu Koxa,"* and *"The Sound of the Flute,"* analyzing how collective unconscious structures and archetypal models are artistically represented within these texts. The research is based on the theoretical approaches of Sigmund Freud, Carl Gustav Jung, Jan Assmann, and Maurice Halbwachs concerning psychoanalysis, archetypes, and cultural memory. The analysis demonstrates that motifs such as the saz, the flute, the wise old man, the master craftsman, conscience, and moral responsibility function as symbolic expressions of collective memory and national identity. In *"Saz,"* music appears as a model of collective harmony; in *"Telegram,"* archetypal memory is reconstructed through ethical choice and moral responsibility; in *"Kollu Koxa,"* the wise old man archetype embodies collective consciousness and folk wisdom; while in *"The Sound of the Flute,"* trauma and sublimation are expressed through acoustic symbols connected with collective memory. The study concludes that archetypal memory in Isa Mughanna's prose is not presented as a static phenomenon but as a dynamic psychological and cultural process continuously transformed under historical and social conditions. The writer's artistic system reveals the continuity of national identity through symbolic and archetypal structures rooted in the collective unconscious.

Keywords: archetypal memory, collective unconscious, psychoanalytic criticism, cultural memory, Isa Mughanna

Introduction. In twentieth-century Azerbaijani prose, the artistic representation of issues related to national identity, cultural memory, and the deep layers of human psychology has gained particular significance in recent literary studies. Historical cataclysms, ideological pressures, wars, and modernization processes caused serious disruptions in the traditional structure of collective memory, and these disruptions led literature to present the inner world of human beings through complex psychological models. In this context, the творчество of Isa Mughanna is not limited merely to the depiction of social and domestic events. His works foreground such fundamental problems as the ontological foundations of human existence, the psychological mechanisms of collective memory, and the restoration of archetypal structures.

Isa Mughanna's works *"Saz," "Telegram," "Kollu Koxa,"* and *"The Sound of the Flute"* constitute an important stage in Azerbaijani prose in terms of the artistic modeling of national memory. In these works, the interaction between the individual's inner psychological experience and collective consciousness manifests itself within a distinctive artistic system. The writer's characters are not merely representatives of a specific social environment; at the same time, they are carriers of the collective unconscious. From this perspective, Isa Mughanna's oeuvre provides rich material for psychoanalytic and mythopoetic analysis.

According to psychoanalytic theory, alongside conscious experience, the human psyche also contains archaic structures that preserve traces of collective experience. Carl Gustav Jung characterizes archetypes as universal forms of the collective unconscious and notes that archetypes constitute the content of the collective unconscious and emerge in myths, dreams, and artistic creativity (Yung, 1981, p. 42). This idea demonstrates that the figures frequently encountered in Isa Mughanna's works—such as the father, the wise old man, the craftsman, the hero, and the musician—possess not only realistic characteristics but are also connected with the deep layers of collective memory. The theory of cultural memory is likewise of particular importance in this context. According to Jan Assmann's theory of cultural memory, cultural memory is a symbolic system of knowledge that shapes the collective identity and self-awareness of society (Assmann, 1992, p. 37). From this perspective, motifs such as the saz, the flute, the village setting, and the master-apprentice relationship are not merely ethnographic details; rather, they are symbolic manifestations of collective memory. Maurice Halbwachs, linking collective memory with social structure, notes that collective memory is the reconstruction of individual recollections within a social framework (Halbvaks, 1992, p. 38). The parallel development of individual and collective experience in Isa Mughanna's prose confirms this theoretical proposition. While living through their personal destinies, the writer's characters simultaneously become carriers of national memory.

Sigmund Freud's psychoanalytic conception, in turn, provides an important methodological basis for

the artistic analysis of trauma and sublimation mechanisms. Freud stated that the "unconscious" constitutes the principal part of the psyche and covertly influences human behavior (Freyd, 1960, p. 23). The inner conflict, silence, indecisiveness, and moral tension frequently observed in the behavior of Isa Mughanna's characters function as artistic expressions of these hidden psychological mechanisms. From this perspective, the character of Cümrü attracts attention as a bearer of silence and inner tension. In *"Saz,"* music expresses the harmonious structure of national memory, whereas in *"Telegram"* the problem of moral choice comes to the forefront. In *"Kollu Koxa,"* an archetypal model of folk wisdom is created, while in *"The Sound of the Flute"* the fragmentation caused by war trauma in the human psyche is perceived through aesthetic sensibility. Each of these works reveals different aspects of collective memory, and when considered together, they present a model for the restoration of archetypal structures in Isa Mughanna's creative world. A particularly noteworthy aspect is that archetypal memory in the writer's works is not presented merely as an idealization of the past; rather, this memory is reactivated under the conditions of the psychological crisis generated by the modern era. In general terms, archetypal memory in Isa Mughanna's prose is presented not as a static phenomenon but as a dynamic process.

Research. The purpose of this article is to investigate the problem of the restoration of archetypal memory in Isa Mughanna's works *"Saz," "Telegram," "Kollu Koxa,"* and *"The Sound of the Flute"* from psychoanalytic and mythopoetic perspectives. The principal objective of the study is to determine how the structural elements of the collective unconscious are embodied in the system of artistic images, to analyze the transformational characteristics of archetypal motifs, and to reveal the poetic mechanism of the artistic reconstruction of national memory.

Thus, Isa Mughanna's creative work functions not only as an aesthetic phenomenon in Azerbaijani prose but also as an artistic model presenting the psychological map of collective memory. Through this model, the continuity and transformation of archetypal structures existing in the deep layers of national identity become subjects of discussion.

Let us pay attention to psychoanalytic and mythopoetic approaches in the understanding of collective memory. In order to investigate the manifestation of archetypal memory in literary texts, it is first necessary to refer to the main principles of psychoanalytic theory. The psychoanalytic approach perceives literature not merely as an aesthetic phenomenon but also as a symbolic form of expression of human consciousness and the unconscious. According to this approach, artistic images often encompass a broader semantic field than individual experience and reflect the archaic layers of collective experience.

Sigmund Freud, explaining the human psyche as the interaction between conscious and unconscious spheres, stated that the "unconscious" constitutes the principal part of the psyche and covertly influences human behavior (Freyd, 1960, p. 23). According to Freud, the unconscious sphere stores repressed desires, fears, and traumatic experiences, which emerge in various symbolic forms. From this perspective, literature functions as a form of expression of the unconscious. Carl Gustav Jung expanded the concept of the unconscious by introducing the notion of the collective unconscious. According to Jung, the collective unconscious encompasses universal psychological structures formed throughout the historical development of humanity and independent of individual experience; in other words, archetypes constitute the content of the collective unconscious, and these archetypes emerge in myths, religions, and artistic creativity (Jung, 1981, p. 42).

The concept of archetype occupies a special place in psychoanalytic literary studies. Archetypes are universal semantic models underlying concrete images. For example, the father archetype represents the idea of authority and law, the mother archetype symbolizes protection and origin, while the wise old man archetype represents collective experience and knowledge. In Isa Mughanna's creative world, the images of the father, master, wise elder, and artist constitute an important part of archetypal structures. These images possess not only concrete social functions but also serve as symbolic expressions of collective memory.

The theory of cultural memory makes it possible to explain the social function of archetypal structures. Jan Assmann, emphasizing the role of memory in the formation of collective identity, writes that "cultural memory is a reservoir of symbolic knowledge that enables society's self-awareness" (Assmann, 2011, p. 37). From this perspective, cultural memory is not merely the recollection of past events but a mechanism of social self-identification. Maurice Halbwachs, examining the social nature of collective memory, states that collective memory is the reconstruction of individual recollections within a social framework (Halbvaks, 1992, p. 38). This idea conditions the fact that individual destinies in literary texts acquire collective semantic meaning.

In Isa Mughanna's works, memory is presented not only as an individual psychological phenomenon but also as a social phenomenon. While experiencing their personal lives, the writer's characters simultaneously become carriers of collective memory. In this respect, the literary text functions as the transformation of individual experience into a collective semantic model. The motif of trauma is particularly evident in Isa Mughanna's *"The Sound of the Flute."* The conditions of war create deep disruptions in collective psychology, and these disruptions are expressed through the symbol of music. The psychoanalytic approach demonstrates that music often functions as a means of expressing unconscious emotional experience. In this context, musical instruments such as the saz and the flute in Isa Mughanna's creative work function as acoustic models of archetypal memory.

The process of restoring archetypal memory is not merely a mechanical repetition of the past; rather, it signifies the reconstruction of collective identity under new social conditions. Assmann notes that memory is not simply the preservation of the past but its reinterpretation in every historical period (Assmann, 2011, p. 121). This idea explains why archetypal motifs in Isa

Mughanna's works are presented in transformed forms. The writer's characters are not passive carriers of archaic structures.

Thus, psychoanalytic and cultural memory theories provide a methodological basis for explaining the problem of the restoration of archetypal memory in Isa Mughanna's creative work. On the basis of this framework, it becomes possible to determine how the structural elements of the collective unconscious are transformed within the writer's artistic system.

Isa Mughanna's novella *"Saz"* is one of the texts in the writer's oeuvre where the problem of the restoration of archetypal memory is expressed most clearly. In this work, the saz is not merely a musical instrument but a form of expression of collective memory, national identity, and cultural continuity. Within the semantic structure of the work, the motif of the saz functions as a carrier of archaic cultural codes and plays the role of mediator between individual psychological experience and collective memory. In the common Turkic cultural tradition, the saz has historically served as one of the principal transmitters of oral memory. The art of the ashig is not only an aesthetic phenomenon but also a mechanism for preserving collective historical experience. In this regard, the saz functions as an archetypal symbol.

In *"Saz,"* the principal function of the musical motif is the preservation of collective harmony. The writer presents the sound of the saz not merely as an aesthetic phenomenon but also as a moral mechanism regulating social relations. Music brings people together, activates collective memory, and creates spiritual communication among individuals. The function of the saz in the work is not limited solely to the expression of individual emotions. Assmann, noting that collective memory is preserved through symbolic structures, writes that cultural memory is transmitted from generation to generation through symbols (Assmann, 2011, p. 112). The saz is one of these symbolic structures.

One of the most striking aspects of *"Saz"* is the restorative function of music in social harmony. The writer presents the sound of the saz as a regulator of collective emotional states. This feature demonstrates that the saz is not only an aesthetic object but also an element of social psychology. Through the motif of the saz, Isa Mughanna presents the restoration of archetypal memory not merely on the level of nostalgia but as a memory that regains functionality under modern conditions. Through the saz, the writer's characters not only remember the past but also attain spiritual stability.

The psychoanalytic analysis of *"Saz"* demonstrates that music here functions as a form of expression of unconscious emotional experience. The sound of the saz reduces the inner tension of individuals and serves the restoration of collective harmony. In *"Saz,"* the process of restoring archetypal memory is realized through music. This process establishes a connection between individual psychological experience and collective cultural experience.

Thus, in *"Saz,"* the motif of the saz functions as an acoustic model of archetypal memory and fulfills the function of restoring collective identity. This feature demonstrates that the archetype of music plays an important semantic role in the creative work of Isa Mughanna.

Isa Mughanna's novella *"Telegram"* presents the problem of the restoration of archetypal memory from a different perspective. If in *"Saz"* collective memory was restored through the archetype of music, in *"Telegram"* this process is associated with the individual's moral choice, inner responsibility, and the problem of conscience. The work primarily focuses on the psychological tension arising between the individual's inner world and the social environment. From a psychoanalytic perspective, the principal problem of *"Telegram"* is related to the structure of the superego. According to Sigmund Freud, the superego is the manifestation of social norms and moral values formed within the psyche. He wrote that the superego is the internal continuation of parental authority and regulates individual behavior (Freyd, 1961, p. 67). From this perspective, the protagonist of *"Telegram"* does not merely react to a concrete event but determines his own position within the collective moral system.

In the work, the telegram motif functions not only as a means of communication but also as a medium for realizing psychological transformation. The receipt of the telegram creates tension within the protagonist's inner state and places him before a moral choice. This choice is not only an individual matter but is also connected with the continuity of collective memory. One of the most important psychological aspects of the work is the hesitation observed in the protagonist's inner monologues. From a psychoanalytic point of view, this hesitation arises from the conflict between the id and the superego. Freud noted that "the id is the source of instinctual tendencies, whereas the superego is the expression of social prohibitions" (Freud, 1960, p. 31). In *"Telegram,"* the protagonist remains caught between these two psychological structures. On the one hand, there are individual emotional reactions; on the other hand, there is a sense of social responsibility. This psychological condition itself represents the process of moral decision-making related to the preservation of collective memory.

It should be noted that in *"Telegram"* archaic forms manifest themselves in such concepts as conscience, duty, and responsibility. One of the essential features of the work is the transition of moral responsibility from the individual level to the collective level. The protagonist's behavior is not merely the result of personal emotions; rather, it is shaped under the influence of social values. From a psychoanalytic perspective, the semantic structure of the work presents a model in which the individual's inner conflict is resolved through the collective ethical system. This model reveals the moral aspect of the restoration of archetypal memory. In *"Telegram,"* the preservation of collective memory is not merely the recollection of the past; this process is realized through ethical choice.

Thus, in *"Telegram,"* archetypal memory is restored through the individual's moral responsibility. This process functions as an important psychological mechanism ensuring the continuity of collective identity.

Isa Mughanna's novella *"Kollu Koxa"* is one of the texts in the writer's oeuvre where the problem of the restoration of archetypal memory is presented in the clearest and most systematic manner. In the work, the figure of Kollu Koxa functions not only as a representative of a particular social environment but also as a symbolic expression of collective experience and national memory. This character may be regarded as one of the classical examples of the wise old man archetype in Azerbaijani prose. Carl Gustav Jung also viewed the wise old man archetype as one of the principal structural elements of the collective unconscious (Jung, 1981, p. 217). From this perspective, Kollu Koxa is not merely the bearer of individual experience but also the representative of collective memory.

The primary function of the image of Kollu Koxa in the work is the preservation of social harmony. When responding to events, he does not act solely from an individual position. This feature indicates the social function of archetypal memory. Kollu Koxa combines rational thinking with folk wisdom in his attitude toward events. This characteristic is one of the main signs of archetypal memory. In *"Kollu Koxa,"* this structure is presented through folk wisdom. Kollu Koxa functions as a figure creating balance within social relations. He makes decisions not under the influence of individual emotions but as the result of collective experience. In Freud's terms, Kollu Koxa's superego exists within the ethical standards of society, while his individual characteristics are almost dissolved within the collective. By fulfilling the function of the collective superego, the image of Kollu Koxa acquires authority. In the work, Kollu Koxa is perceived not only as a figure giving advice but also as a moral regulator of social relations.

In *"Kollu Koxa,"* archetypal memory is presented not merely as an individual psychological phenomenon but also as a social phenomenon. Kollu Koxa functions as the principal semanteme serving the preservation of collective identity. One of the important features of the work is that the image of Kollu Koxa is not presented as an idealized hero; rather, he is a part of everyday life, and precisely for this reason he embodies the connection between archetypal structures and real life.

Thus, the image of Kollu Koxa presents a model for the restoration of collective consciousness and demonstrates that the archetype of the wise old man plays an important semantic role in Isa Mughanna's creative work.

Isa Mughanna's novella *"The Sound of the Flute"* is one of the works in the writer's oeuvre that presents the problem of the restoration of archetypal memory in the most dramatic and psychologically profound manner. In this work, collective trauma, the collapse of social relations under wartime conditions, and the fragmentation occurring within the human inner world are expressed through the acoustic symbol of the flute's sound. The artistic structure of the work demonstrates that cultural memory is preserved and restored not only through social institutions but also through symbolic-aesthetic forms.

According to psychoanalytic theory, trauma is a psychological event that cannot be fully assimilated by consciousness. Freud wrote that trauma is repeatedly experienced within the psyche, noting that traumatic experience is preserved in the unconscious sphere and re-emerges in various symbolic forms (Freud, 1917, p. 245). In *"The Sound of the Flute,"* war trauma is not directly depicted; however, its psychological consequences are felt throughout every sphere of village life. In the work, the character of Cümrü functions as the bearer of traumatic experience. Drawing on Jacques Lacan's approach that the father is the symbolic representative of law and social structure, it may be said that Cümrü's inner condition demonstrates the psychological void arising from the absence of the father figure under wartime conditions. Lacan explained the father function as a principal element of the symbolic order (Lacan, 2006, p. 230). The absence of the father figure creates instability within Cümrü's psyche.

Cümrü's turning toward the flute may be explained through the mechanism of sublimation. It should be recalled that Freud characterized sublimation as the redirection of instinctual energy toward aesthetic activity (Freud, 1917, p. 246). In this respect, the sound of the flute is the aesthetic expression of emotional pain. The motif of the flute is not only the result of an individual psychological process but also an acoustic model of collective memory. Within the village environment, the sound of the flute becomes a means of expressing collective emotional states. In *"The Sound of the Flute,"* trauma is not merely an individual psychological phenomenon; it transforms the structure of collective consciousness. Wartime conditions create changes in the structure of collective memory, and these changes are expressed through music.

In the work, the character of Cümrü represents a more acute form of traumatic fragmentation. Under wartime conditions, he struggles to preserve emotional stability, and this state may be explained psychoanalytically as an affective disturbance. Freud noted that "repressed emotions return in the form of various symptoms" (Freud, 1960, p. 59). Cümrü's behavior constitutes an artistic model of this symptomatic return. When Cümrü refuses to play the flute, the mechanism of aesthetic sublimation is disrupted, and traumatic energy consequently emerges in a destructive form.

The character of Isfandiyar kişi, on the other hand, functions as the guardian of archetypal memory. He is presented as a master craftsman who makes saz instruments and boxwood flutes, and this characteristic is an important feature of the master archetype. Jung, characterizing the wise old man archetype as the bearer of collective experience, wrote that the wise old man archetype fulfills the function of collective knowledge and moral guidance (Jung, 1981, p. 217). In the literary text, the figure of Isfandiyar kişi functions as a character ensuring the continuity of archetypal memory. He is not merely a craftsman producing musical instruments but also a transmitter of cultural memory.

In *"The Sound of the Flute,"* music performs not only the aesthetic transformation of trauma but also the function of preserving collective identity. In this respect, the motif of the flute forms a semantic parallel with the motif of the saz. If music preserves harmony in *"Saz,"* then in *"The Sound of the Flute"* music expresses the attempt to restore fragmented harmony.

Thus, in *"The Sound of the Flute,"* archetypal memory is restored through aesthetic symbols under traumatic conditions. This process functions as an important psychological mechanism ensuring the continuity of collective identity.

Conclusion. The conducted psychoanalytic and mythopoetic analysis demonstrates that the creative work of Isa Mughanna constitutes an important stage in Azerbaijani prose in which the problem of the restoration of archetypal memory is systematically modeled artistically. The writer's works *"Saz," "Telegram," "Kollu Koxa,"* and *"The Sound of the Flute"* present different structural elements of the collective unconscious through diverse artistic forms and reveal the psychological foundations of national identity. In these works, memory does not merely serve the function of recalling the past; rather, it is presented as a structure ensuring the moral integrity of the individual.

The psychoanalytic approach demonstrates that archetypal structures are expressed through symbolic forms in literary texts. Jung emphasized that archetypes are the principal elements of the collective unconscious, writing that "archetypes are the primordial forms of human psychic life and emerge in cultural creativity" (Jung, 1981, p. 57). In Isa Mughanna's works, such images as the saz, the flute, the master craftsman, and the wise old man are precisely artistic manifestations of these primordial forms.

As a result of the research, the following scientific conclusions have been reached:

1. In Isa Mughanna's creative work, archetypal memory is one of the principal semantic structures serving the preservation of collective identity. In his works, this reservoir of knowledge is preserved through music, folklore, and folk wisdom.

2. In *"Saz,"* the archetype of music symbolizes collective harmony. The sound of the saz functions as a moral mechanism regulating social relations and ensuring collective emotional stability.

3. In *"Telegram,"* archetypal memory is presented through the model of moral responsibility. The protagonist's confrontation with ethical choice demonstrates the normative function of collective memory.

4. In *"Kollu Koxa,"* the wise old man archetype functions as a symbol of collective consciousness. The image of Kollu Koxa is a generalized model of folk experience and ensures the continuity of collective identity.

5. In *"The Sound of the Flute,"* the mechanisms of trauma and sublimation form the acoustic model of archetypal memory. In this respect, the flute motif represents the aesthetic transformation of trauma.

6. The character of Isfandiyar kişi is an artistic model of the master archetype and fulfills the function of transmitting cultural memory. This image demonstrates that archetypal memory exists not only on the level of ideas but also within social practice.

7. The character of Cümrü demonstrates the fragmentation created by collective trauma within individual psychology. His behavior functions as the result of repression and affective tension.

8. In Isa Mughanna's creative work, archetypal memory is not a static phenomenon; it transforms in accordance with historical conditions. In the writer's works, the process of restoring archetypal memory creates a connection between individual psychological experience and collective cultural experience. Isa Mughanna's creative work demonstrates that national identity is not merely the result of historical memory but is also connected with the continuity of psychological structures. The writer's artistic model reveals how the collective unconscious becomes actualized in cultural creativity.

Thus, the conducted analysis demonstrates that the process of restoring archetypal memory in Isa Mughanna's creative work possesses a multilayered semantic structure. This structure is explained more clearly through psychoanalytic and mythopoetic approaches. The writer's works occupy an important place in Azerbaijani prose in terms of the artistic modeling of the collective unconscious and provide rich material for the study of the psychological foundations of national identity.

References

1. Assmann, A. (2011). *Cultural memory and Western civilization*. Cambridge: Cambridge University Press. 401 p.

2. Freud, S. (1960). *Introductory lectures on psychoanalysis*. New York: Norton. 512 p.

3. Freud, S. (1961). *The ego and the id*. New York: Norton. 80 p.

4. Halbwachs, M. (1992). *On collective memory*. Chicago: University of Chicago Press. 182 p.

5. Huseynov, F. (2010). *Twentieth-century Azerbaijani prose: Issues of poetics*. Baku: Nurlan. 256 p.

6. Aliyev, R. (2014). *The problem of national memory in Azerbaijani literature*. Baku: Elm. 224 p.

7. Mughanna, I. (2005). *Selected works* (Vol. I). Baku: Sharq-Garb. 472 p.

8. Mughanna, I. (1987). *Saz*. In *Selected works* (pp. 45–112). Baku: Yazıçı.

9. Mughanna, I. (1987). *Telegram*. In *Selected works* (pp. 113–168). Baku: Yazıçı.

10. Mughanna, I. (1987). *Kollu Koxa*. In *Selected works* (pp. 169–214). Baku: Yazıçı.

11. Mughanna, I. (1987). *The Sound of the Flute*. In *Selected works* (pp. 215–260). Baku: Yazıçı.

12. Mammadov, K. (2011). *The problem of psychologism in Azerbaijani prose*. Baku: Elm. 198 p.

13. Jung, C. G. (1981). *The archetypes and the collective unconscious*. Princeton: Princeton University Press. 451 p.

14. Jung, C. G. (1964). *Man and his symbols*. London: Picador. 320 p.

15. Hashimov, A., & Babazade, Z. (2026). Restoration of Archetypal Memory in Elchin's Novel Mahmud and Maryam. *EuroGlobal Journal of Linguistics and Language Education*, *3*(2), 143-152.

FROM TRADITION TO TECHNOLOGY: MODERN WAYS OF LEARNING ENGLISH

Mammadova Rubaba
Senior lecturer of the chair "English and methods"
Nakhchivan State University, Azerbaijan
https://orcid.org/0009-0001-5018-9265
Qasimzade Inji
I year student of the specialty " Information technologies"
Nakhchivan State University, Azerbaijan
Babayeva Ayshen
Teacher of the subject section of foreign languages
Naakhchivan Military College, Azerbaijan
Jafarova Qizkhanum
Teacher of the subject section of foreign languages
Naakhchivan Military College, Azerbaijan
DOI: 10.5281/zenodo.20609587

Abstract

This paper examines the shift from traditional to modern technological methods in learning English and their impact on language acquisition. Traditional approaches, such as textbook-based instruction and grammar-translation methods, help develop grammatical accuracy but often limit communicative competence and practical language use. Modern technologies, including online platforms, mobile applications, artificial intelligence tools, and virtual learning environments, have made language learning more interactive, flexible, and learner-centered. These tools provide personalized feedback, adapt to learners' needs, and allow access to resources anytime and anywhere. A major advantage of modern methods is their emphasis on communication skills. Through social media, discussion forums, and language exchange platforms, learners can interact with native speakers and improve both linguistic and intercultural communication skills. Multimedia resources and gamification also increase motivation and engagement by presenting language in authentic and interactive ways.

Despite these benefits, technology-based learning also has challenges, such as digital distraction and overreliance on technology. Therefore, combining traditional teaching methods with modern technological tools is essential for effective English language learning

Keywords: Digital technologies, online education, mobile applications, artificial intelligence, communicative approach, traditional methods

INTRODUCTION

English language teaching (ELT) has undergone profound changes over the past century, reflecting broader developments in pedagogy, psychology, and educational technology. Historically, language learning was dominated by traditional approaches such as the Grammar-Translation Method and later the Audio-Lingual Method. These approaches emphasized memorization of vocabulary, explicit grammar instruction, and translation exercises. While they were effective in building foundational knowledge of language structure, they often failed to develop learners' communicative competence and spontaneous language use in real-life contexts. With the rise of communicative approaches in the late 20th century, the focus of language teaching gradually shifted from accuracy to fluency, and from teacher-centered instruction to learner-centered education. This shift was strongly influenced by theoretical contributions such as Krashen's Input Hypothesis, which argues that language acquisition occurs when learners are exposed to comprehensible input slightly above their current level of proficiency [Krashen]. In addition, Vygotsky's Sociocultural Theory emphasizes that learning is a socially mediated process, where interaction with more capable peers or instructors plays a crucial role in cognitive and linguistic development [19]. These theories laid the foundation for modern communicative language teaching approaches. In the 21st century, the rapid development of digital technologies has further transformed ELT. The integration of computer-assisted language learning (CALL), mobile-assisted language learning (MALL), artificial intelligence tools, and online learning platforms has created new opportunities for more flexible, interactive, and personalized education. Learners are no longer limited to classroom environments; instead, they can access authentic materials, communicate with native speakers, and practice language skills through digital platforms anytime and anywhere. In Azerbaijan, including Nakhchivan State University, researchers have actively contributed to this evolving field. Scholars such as Rubaba Mammadova have highlighted the importance of authentic learning environments in improving students' communicative competence and motivation [Mammadova]. Similarly, studies by Javid Babayev, Turkan Ismayilli, and Dilbar Orujova emphasize the effectiveness of communicative, cognitive, and technology-enhanced approaches in modern language education [3]; [10]; [16]. Their research shows that combining traditional pedagogical principles with modern digital tools leads to more effective and sustainable language learning outcomes [9]. Therefore, this paper aims to analyze the transition from traditional to modern methods of English language learning, focusing on the role of technology, communicative competence, and learner-centered instruction. It also explores how

the integration of international theories and local research contributes to a more comprehensive understanding of effective ELT practices in contemporary education systems.

Traditional Approaches in English Language Teaching

Traditional English language teaching methods have historically been based on structural linguistics and behaviorist learning theories. The Grammar-Translation Method (GTM) emphasizes explicit grammar instruction, vocabulary memorization, and translation of texts from the target language into the native language [13]. Similarly, the Audio-Lingual Method relies on repetition, drilling, and habit formation to develop language skills. Although these methods were widely used and still have certain pedagogical value, their limitations have been well documented in modern ELT research. According to Richards and Rodgers (2014), traditional approaches are effective in developing reading comprehension and grammatical accuracy but often fail to promote spontaneous speaking and listening skills [17].

In the context of Azerbaijani higher education, similar challenges have been observed. Research conducted at Nakhchivan State University indicates that students educated primarily through traditional methods tend to have difficulties in oral communication and real-life language application [2]. This suggests that knowledge of rules does not automatically translate into communicative competence.

Rubaba Mammadova also emphasizes that traditional instruction often lacks authenticity and does not reflect real communicative situations, which reduces student motivation and engagement [15]. Therefore, while traditional methods provide foundational knowledge, they are insufficient for developing full communicative proficiency.

Communicative Language Teaching and the Shift in Pedagogy

The emergence of Communicative Language Teaching (CLT) represents one of the most significant paradigm shifts in the history of English language pedagogy. Unlike traditional methods that prioritize grammatical accuracy and explicit rule learning, CLT focuses on the functional use of language in meaningful, real-life contexts. The central idea is that language is not merely a system of rules but a tool for communication, interaction, and social participation. From a theoretical perspective, CLT is strongly influenced by functional linguistics and interactionist theories of language acquisition [5]. Hymes' concept of "communicative competence" expanded the understanding of language ability beyond grammatical knowledge to include sociolinguistic, discourse, and strategic competence. In this view, being able to use English effectively means not only forming correct sentences but also knowing when, where, and how to use them appropriately in different communicative situations.

Dörnyei (2001) emphasizes that motivation plays a crucial role in language learning success, and communicative classrooms significantly increase learner engagement by making learning purposeful and interactive [7]. In CLT-based environments, students are not passive recipients of knowledge; instead, they actively participate in pair work, group discussions, role-plays, problem-solving tasks, and simulations that reflect authentic communication scenarios. This active participation helps learners develop fluency, confidence, and spontaneity in language use.

Another important aspect of CLT is its learner-centered nature. The teacher's role shifts from being the primary source of knowledge to a facilitator who guides, supports, and creates opportunities for communication. This shift aligns with constructivist learning theory, which suggests that learners construct knowledge through interaction and experience rather than passive absorption of information. As a result, classroom dynamics become more flexible, collaborative, and student-oriented. Furthermore, CLT integrates the concept of task-based learning (TBLT), where learners complete meaningful tasks using the target language. These tasks—such as planning a trip, solving a problem, or conducting an interview—encourage learners to use English as a practical tool rather than an academic subject. Ellis (2003) argues that task-based instruction enhances both fluency and accuracy by exposing learners to authentic language use while still maintaining pedagogical focus. In addition, communicative approaches reduce language anxiety, which is a major barrier in second language acquisition. When students engage in interactive and supportive classroom activities, they feel more comfortable taking risks and expressing themselves. This emotional aspect of learning is particularly important, as affective filters can significantly influence language acquisition success, as noted in Krashen's Affective Filter Hypothesis [14].

Overall, Communicative Language Teaching represents a shift from knowledge-based instruction to skill-based, interaction-driven education. It encourages learners to use English meaningfully, develop communicative confidence, and engage in authentic social interaction. In comparison to traditional methods, CLT provides a more dynamic, realistic, and psychologically supportive environment for language acquisition, making it a cornerstone of modern English language teaching practices.

Technology Integration in Modern ELT

The integration of technology into English Language Teaching (ELT) has fundamentally reshaped the nature of language learning in the 21st century. Unlike traditional classroom-bound instruction, modern digital tools enable learners to access English in diverse, authentic, and interactive environments. This transformation is largely driven by the rapid development of Computer-Assisted Language Learning (CALL), Mobile-Assisted Language Learning (MALL), and artificial intelligence-based educational systems [1]. One of the most significant advantages of technology-enhanced language learning is accessibility. Learners are no longer restricted by time or place; instead, they can engage with English anytime through smartphones, tablets, and computers. Platforms such as online learning systems, language learning applications, and virtual classrooms provide continuous exposure to the target language. This constant interaction supports language acquisition by increasing input frequency and variety.

Chapelle (2003) argues that technology plays a crucial role in facilitating meaningful input and interaction, which are essential for successful second language acquisition. Digital environments allow learners to engage with multimedia content such as videos, podcasts, interactive exercises, and simulations [6]. These resources expose learners to authentic language use, including different accents, speech rates, and communicative contexts that are often absent in traditional classrooms.

Another important development is the use of artificial intelligence (AI) in language learning. AI-powered systems can analyze learners' performance, identify weaknesses, and provide personalized feedback. This adaptive learning approach ensures that each learner receives instruction tailored to their specific needs and proficiency level. As a result, learning becomes more efficient, targeted, and learner-centered.

Mobile-Assisted Language Learning (MALL) further extends the possibilities of ELT by integrating language learning into daily life. Mobile applications allow learners to practice vocabulary, grammar, pronunciation, and listening skills in short, manageable sessions. This microlearning approach supports long-term retention and encourages consistent practice. Additionally, features such as gamification—points, levels, and rewards—enhance motivation and engagement by making learning more interactive and enjoyable. Technology also facilitates global communication. Through social media platforms, online forums, and language exchange applications, learners can interact with native speakers and other learners worldwide [11]. This real-time communication promotes intercultural awareness and develops pragmatic competence, which is essential for effective communication in diverse contexts.

However, it is important to note that technology is not a standalone solution. Its effectiveness depends on how it is integrated into pedagogical practice. Without proper guidance, learners may experience information overload or become distracted by non-educational content. Therefore, teachers play a crucial role in selecting appropriate digital tools and designing meaningful learning activities.

In conclusion, technology integration in ELT has expanded the boundaries of language learning, making it more flexible, interactive, and personalized. When used effectively, digital tools not only enhance linguistic competence but also support learner autonomy, motivation, and global communication skills.

Cognitive and Authentic Learning Perspectives

Modern ELT is not only communicative but also cognitive in nature. Cognitive approaches focus on how learners process, store, and retrieve language information.

Turkan Ismayilli's research highlights that cognitive constructions in language learning help students understand deeper semantic relationships and structural patterns. This improves long-term retention and meaningful language use [12]. Authentic learning, as described by Herrington and Oliver (2000), involves tasks that reflect real-world situations [8]. These tasks increase learner engagement and help bridge the gap between theoretical knowledge and practical use.

Dilbar Orujova's studies on listening skills show that exposure to authentic audio materials significantly improves comprehension and pronunciation. Intensive and extensive listening practices help learners develop both bottom-up and top-down processing skills [16]. Thus, modern ELT integrates cognitive development, authenticity, and communication into a unified learning framework.

Challenges of Modern and Technology-Based Learning

Despite the many advantages of modern, technology-enhanced English language teaching, there are also significant challenges that must be considered. The integration of digital tools into education does not automatically guarantee improved learning outcomes; rather, its effectiveness depends on pedagogical design, teacher competence, and learner responsibility.

One of the most common challenges is digital distraction. While mobile devices and online platforms provide access to rich educational resources, they also expose learners to non-academic content such as social media, games, and entertainment applications [4]. This constant availability of distractions can reduce concentration, limit study time, and negatively affect learning efficiency. As Selwyn (2011) argues, educational technology is not inherently beneficial or harmful; its impact depends on how it is used within structured learning environments [18].

Another major issue is the problem of unequal access to technology. In many educational contexts, students may not have access to high-speed internet, modern devices, or stable digital infrastructure. This creates a digital divide, where some learners benefit from advanced technological tools while others are left behind. Such inequality can lead to differences in academic performance and reduce the overall effectiveness of technology-based education systems.

In addition, overreliance on technology can also become a limitation. While artificial intelligence tools, translation applications, and automated grammar checkers are useful, excessive dependence on them may reduce learners' critical thinking and problem-solving abilities. Students may rely on automatic corrections without fully understanding the underlying language rules, which can hinder long-term language development. Another important challenge is the reduced role of direct human interaction in some technology-based learning environments. Although online communication tools enable global interaction, they cannot fully replace the immediacy, emotional feedback, and social dynamics of face-to-face classroom communication. Teacher-student interaction remains essential for motivation, guidance, and emotional support, especially for beginner-level learners. Furthermore, effective integration of technology requires a high level of digital literacy from both teachers and students. Educators must be able to select appropriate tools, design interactive tasks, and manage virtual

classrooms effectively. Without proper training, technology may be underutilized or misused, reducing its potential benefits in language education.

Finally, there is the issue of information overload. The internet provides an unlimited amount of language learning materials, which can sometimes confuse learners rather than help them. Without clear guidance, students may struggle to choose reliable and appropriate resources, leading to fragmented or inefficient learning experiences. In conclusion, while modern technology offers powerful opportunities for enhancing English language learning, it also introduces several pedagogical, social, and cognitive challenges. To ensure effective outcomes, it is essential to combine technological tools with strong instructional design, teacher guidance, and balanced classroom practices.

Conclusion

The transition from traditional to technology-based English language learning represents a fundamental shift in educational practice. Traditional methods provide essential grammatical foundations, while modern approaches enhance communication, motivation, and learner autonomy. The integration of theories by Krashen, Vygotsky, and Dörnyei with empirical research from scholars such as Mammadova, Babayev, Ismayilli, and Orujova demonstrates that effective language learning requires a balanced, hybrid approach. Ultimately, the most effective ELT model is one that combines structured instruction with authentic, interactive, and technology-supported learning environments. This ensures that learners are not only linguistically competent but also communicatively and culturally prepared for real-world communication.

References

1. Alisoy, H., & Sadiqzade, Z. (2024). Mobile-assisted language learning (MALL): Revolutionizing language education. *Luminis Applied Science and Engineering*, *1*(1), 60-72.

2. Ashrafova, I. (2024). Teaching English to economy and finance majors at Nakhchivan State University. *Sciences of Europe*, (138), 40-46.Babayev, J. S. (2025).

3. How Music Makes You Fluent: Learning English Through Songs. *Acta Globalis Humanitatis et Linguarum*.

4. Babayev, J. (2025). Application of social platforms in language learning. *Acta Globalis Humanitatis et Linguarum*, *2*(3), 141-148.

5. Babayev, J. (2023, December). How to teach a foreign language through CLT. In *Proceedings of the 4th International Scientific Conference" Interdisciplinary Science Studies* (p. 123).

6. Chapelle, C. A. (2003). *English language learning and technology*. John Benjamins.

7. Dörnyei, Z. (2001). *Motivational strategies in the language classroom*. Cambridge University Press.

8. Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology Research and Development*.

9. HUSEYN, Z. I., & Babayev, J. (2025). Effective methods of teaching Azerbaijani to Foreign students. *Porta Universorum*, *1*(9), 118-126.

10. Ismayilli, T., & Nuri, A. (2025). Applications that can be used in Mobile-Assisted Language Education. *Dibon Journal of Education*, *1*(2), 111-119.

11. Ismayilli, T. (2025). The Callan Method in Modern ELT: Accelerating Speaking Fluency Through Direct Oral Instruction. *Global Spectrum of Research and Humanities*, *2*(5), 279-284.

12. Ismayilli, T., Mammadova, R., Mehdizade, N., Orujlu, A., & Heydarova, N. Barriers to Foreign Language Skill Development and Strategies for Effective Improvement. *ELMİ İŞ*, 87.

13. Javid, B. (2023, May). Characteristics of Grammar-Translation method. In V International Scientific and Practical Conference. «Modern science: theoretical and practical view.

14. Krashen, S. D. (1985). *The input hypothesis: Issues and implications*. Longman.

15. Mammadova, R. (2026). Emerging technologies and pedagogical innovations in foreign language teaching. *EuroGlobal Journal of Linguistics and Language Education*, *3*(1), 44-55.

16. Naghiyeva, G., Pashayeva, S., & Orujova, D. A Study on Listening Skill Appropriation in English Language Teaching in Azerbaijan.

17. Richards, J. C., & Rodgers, T. S. (2014). *Approaches and methods in language teaching* (3rd ed.). Cambridge University Press.

18. Selwyn, N. (2011). *Education and technology: Key issues and debates*. Continuum.

19. Vygotsky, L. S. (1978). *Mind in society*. Harvard University Press.

POST-EXECUTION PUNISHMENT AND THE POLITICS OF HELP: DEATH PENALTY, PATRIARCHAL POWER, AND RESTORATIVE FAILURE IN BALLAD OF A WHITE COW

Aliyev Ceyhun
Nakhchivan State University
Akhundov Ayaz
Nakhchivan State University
Aliyev Salman
Nakhchivan State University
ORCİD: 0009-0008-5145-9491
DOI: 10.5281/zenodo.20609683

Abstract

This article examines Behtash Sanaeeha and Maryam Moghaddam's *Ballad of a White Cow* as a critique of capital punishment, patriarchal power, and the failure of legal compensation. The film follows Mina, whose husband Babak is executed for murder and later found innocent. Rather than treating the narrative simply as a case of judicial error, this article argues that execution continues beyond the death of the condemned, shaping the social, economic, and psychological life of those left behind. It introduces two concepts: "post-execution punishment" and "the politics of help." The first describes how punishment persists through stigma, poverty, and surveillance; the second shows how Reza's assistance becomes another form of power because it conceals truth. The film ultimately suggests that justice without recognition and repair becomes violence [1-6]

Keywords: *Ballad of a White Cow*, death penalty, restorative justice, patriarchy, Iranian cinema, post-execution punishment.

Introduction

Ballad of a White Cow appears to be a film about wrongful execution, yet its deeper concern is the impossibility of repairing death through legal compensation. After Babak is executed and later found innocent, his widow Mina is offered money by the state. However, her demand exceeds financial restitution: she seeks truth, public acknowledgment, and moral accountability. In this sense, the film questions not only the fallibility of the legal system but also the legitimacy of a punitive order that relies on irreversible violence [1-4].

This article reads the film through the frameworks of capital punishment, restorative justice, and patriarchy. Restorative justice emphasizes truth, recognition, and repair rather than punishment alone [3]. In the film, however, Mina faces bureaucratic indifference, patriarchal surveillance, and social suspicion. Reza's help further complicates the ethical structure of the narrative: although motivated by guilt, his assistance remains problematic because it hides the truth and controls Mina's access to knowledge. Thus, the film presents punishment as something that continues after execution through social relations, gendered power, and failed repair [1,5,6].

Post-Execution Punishment and the Politics of Help

The central ethical force of *Ballad of a White Cow* lies in its refusal to treat execution as a completed legal event. Babak's death has already occurred when the film's main drama begins, yet the execution continues to shape Mina's life: her economic insecurity, social isolation, daughter Bita's fatherlessness, and confrontation with a state that reduces moral catastrophe to financial compensation. This continuation may be defined as "post-execution punishment": the persistence of penal violence after the condemned person has died. Punishment migrates from Babak's body into the lives of those left behind [1-4].

This concept expands the film's critique beyond judicial error. The wrongful conviction is central, but the deeper problem is the irreversible nature of capital punishment. A prison sentence can, however inadequately, be revised or compensated; death cannot. The film therefore questions the state's claim to possess enough certainty and moral authority to make an irreversible decision. The state can kill, but once truth appears too late, it cannot restore life, dignity, family, or trust [2,4].

Mina's demand exposes the insufficiency of compensation without recognition. The state offers money, but Mina seeks Babak's public exoneration and moral accountability from the legal authority responsible for his death. This demand corresponds to restorative justice theory, which understands harm not only as a violation of law but as a rupture requiring truth, participation, and repair. The film thus contrasts bureaucratic compensation with genuine restoration: payment may address material loss, but it cannot replace acknowledgment or moral repair [1,3].

The film's critique is intensified through its representation of patriarchy. Mina is not only the widow of an executed man; she is a woman whose autonomy is constantly questioned. Her housing, motherhood, work, and relationships are monitored by relatives, landlords, neighbors, and legal institutions. Patriarchy here is not limited to overt male violence. It operates through suspicion, guardianship, social respectability, and the assumption that a woman without male protection is incomplete or morally vulnerable [1,5].

Thus, Babak's execution produces a second punishment for Mina. She must endure grief and poverty while also facing the moral suspicion attached to widowhood and female independence. The domestic

and social sphere becomes an extension of the penal system. The state kills Babak; society narrows Mina's life. In this sense, the film presents a dispersed form of social violence: no public crowd gathers, yet ordinary actors collectively make Mina's existence more fragile and controlled [5,6].

Reza embodies the film's most complex ethical problem. He is not a conventional villain. He feels guilt, helps Mina, and appears to distance himself from the system that produced Babak's death. Yet his help is ethically compromised because it is founded on concealment. Mina does not know who he is, while Reza knows his own involvement in her suffering. This asymmetry turns compassion into control. He decides when to approach her, what to reveal, and how much truth she is allowed to know [1,3,5].

This dynamic may be called "the politics of help." Help becomes political when it does not empower the injured person but manages her access to truth. Reza's aid seems merciful, yet it reproduces the logic of institutional power: someone with authority determines the limits of Mina's knowledge and agency. He attempts to separate himself from state violence, but re-enacts its structure in a softer, more intimate form. The state decided Babak's fate without accountability; Reza now manages Mina's life without full disclosure [1,5].

The film therefore suggests that good intention is insufficient when it remains attached to power. Reza's remorse does not become ethical repair because it avoids the central condition of repair: truth. His secrecy protects himself as much as Mina, perhaps more. By withholding knowledge, he prevents her from deciding freely whether anger, forgiveness, rejection, or reconciliation is possible. In restorative terms, his help lacks mutual recognition; in patriarchal terms, it becomes benevolent control [3,5].

The broader social implication is that violence survives not only through cruelty, but also through procedures, silences, compensations, protective gestures, and moralized forms of control. *Ballad of a White Cow* is therefore not only a critique of the death penalty; it is also a critique of a society in which legal violence, patriarchal discipline, and compassionate domination become entangled. Punishment can continue without a courtroom, prison, or execution chamber. It can continue through everyday life [1,5,6].

Conclusion

Ballad of a White Cow offers a profound critique of capital punishment by shifting attention from the condemned man to those who remain after the execution. Its central insight is that execution does not end punishment; it redistributes punishment. Babak dies, but Mina and Bita inherit the consequences: poverty, stigma, surveillance, grief, and an unresolved demand for truth. The state's offer of compensation cannot repair this damage because the harm is not merely financial. It is existential, social, and moral. A justice system that can kill but cannot restore reveals the limits of punitive power [1-4].

The article's main contribution is to conceptualize this cinematic structure through "post-execution punishment" and "the politics of help." Post-execution punishment names the continuation of penal violence in the lives of survivors. The politics of help names the transformation of aid into domination when truth is withheld and the injured person's agency is restricted. These concepts clarify why Reza's character is so central to the film's ethical force. He is not simply guilty; he is remorseful in a way that remains contaminated by power. His help fails because it does not begin with recognition [1,3,5].

The film thus challenges any narrow understanding of justice as punishment alone. Justice requires truth, accountability, recognition, and the possibility of repair. When these are absent, punishment becomes another form of violence, even when it is legally authorized. In *Ballad of a White Cow*, capital punishment is not condemned only because an innocent man is executed. It is condemned because it represents a model of justice that destroys before it understands, compensates before it acknowledges, and controls before it repairs. The film's most original achievement is its insistence that the death penalty must be judged not only by what it does to the condemned, but also by what it continues to do to the living [1-6].

References

1. Sanaeeha B, Moghaddam M, directors. *Ghasideyeh gave sefid* [*Ballad of a White Cow*] [film]. Iran, France; 2020.

2. Nagin DS, Pepper JV, editors. *Deterrence and the Death Penalty*. Washington, DC: National Academies Press; 2012.

3. Nascimento AM, Andrade J, de Castro Rodrigues A. The psychological impact of restorative justice practices on victims of crimes: a systematic review. *Trauma Violence Abuse*. 2023;24(3):1929-1947. doi:10.1177/15248380221082085.

4. Nayyeri MH. *New Islamic Penal Code of the Islamic Republic of Iran: An Overview*. Colchester: University of Essex Human Rights in Iran Unit; 2012.

5. Gupta M, Madabushi JS, Gupta N. Critical overview of patriarchy, its interferences with psychological development, and risks for mental health. *Cureus*. 2023;15(6):e40216. doi:10.7759/cureus.40216.

6. Nussio E. The "dark side" of community ties: collective action and lynching in Mexico. *American Sociological Review*. 2024;89(4):708-734. doi:10.1177/00031224241253268.

PHYSICAL SCIENCES

PROOF OF THE ABSENCE OF CENTRIPETAL FORCE AND CENTRIPETAL ACCELERATION WHEN A BODY MOVES ALONG A CURVILINEAR TRAJECTORY

Gurevich G.
Doctor in Physics and Mathematics,
Institute for Integration and Professional Adaptation,
Israel, Netanya
Ilyev O.
Dr.-Engineer (energetic),
Israel, Netanya Institute for Integration and Professional Adaptation,
Russia, Moscow
DOI: 10.5281/zenodo.20609755

Abstract
The article proves, that when body T moves along a curvilinear trajectory, including along a circle, a force or momentum acts on body T at an angle to the tangent at any point of the body's trajectory.
When body T moves along the curvilinear trajectory, including along the circumference, there is no centripetal acceleration and centripetal force.

Keywords: motion trajectory, speed, acceleration, force, momentum

DYNAMICS OF MOTION OF A BODY ON AN INEXTENSIBLE ROD AROUND A CENTER OF FORCE

The movement of bodies along a curvilinear trajectory is often found in nature and in human activities.

Consider a system consisting of an elastic rod on which a freely moving body **T** with mass **m** is located. Rod rotates at variable angular speed $\vec{\omega}$ around force center **O** under action of single variable central force.

As a result, a force $\vec{F}_{\text{T}}$, **Fig. 1,** is applied to the body **T.**

We examine the trajectory of the body **T** with mass **m** moving along the rod and rotating with the rod around the force center **O , Fig. 1.**

We examine the magnitude and direction of the forces applied to body **T.**

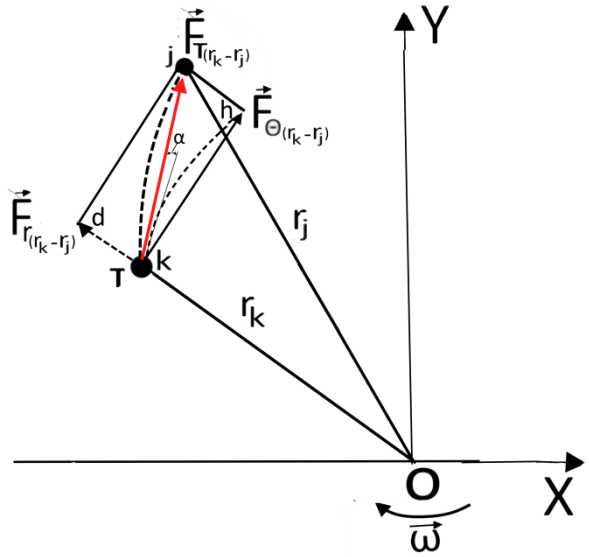


Fig.1
Displacement of body T with mass m around force center O

The body **T** will simultaneously move along variable increasing radii r_θ (r_k ,… r_j), dashed line **kd** , and rotate around the force center **O,** along the circles θ _ (r _ (θ)) of radii r_θ (r_k ,… r_j), dashed line **kh, Fig. 1.**

The body **T**, when rotating around the force center **O** and moving along the radii r_θ (r_k ,… r_j), will move from the point **k,** located on the circle of radius $\boldsymbol{r_k}$ to the point **j** located on the circle of radius r_j (dotted line k - j) under the action of the force $\vec{F}_{\text{T}(r_k - r_j)}$, **Fig. 1.**

1. We examine the trajectory of the body **T** of **Fig. 2,** and the forces acting on the body **T** and the resulting **velocities and accelerations** when it moves from point **O** to point **b** of **Fig. 2.**

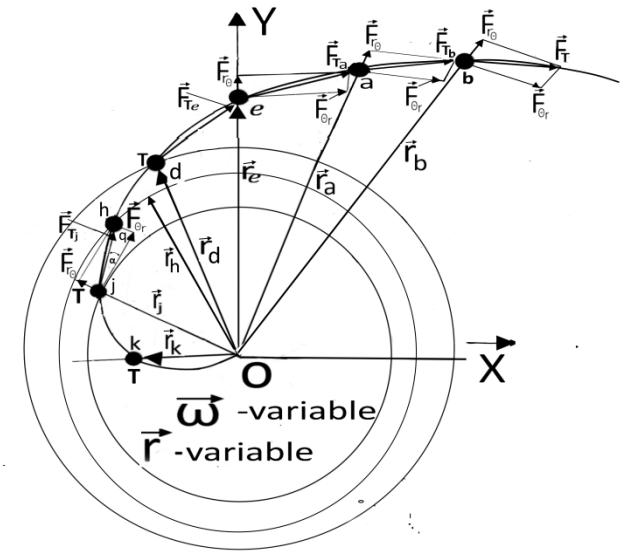


Figure 2
Diagram of body T motion around force center at variable radius r and variable angular velocity ω

Rod rotates under action of variable force created by force center.

Body **T,** freely located on the rod, rotates and moves radially under the action of force $\vec{F}_{\text{T}}$, **Fig. 2.**

The body **T** will move along imaginary circles of variable radii r_θ (r_k , r_j , r_d , r_e . . .) and radially intersect these circles, **Fig. 2.**

Radius - vector $\vec{r}_\theta$ describes the process of moving body **T** between circles θ_r of radii r_θ (r_j , r_d , r_e . . .), **Fig. 2.**

Figure 2 shows for example the movement of body **T** from point **j** to point **h** and to point **d**. Force $\vec{F}_{\text{T}}$**,** applied to body **T** from the side of the force center moves body **T** between circle θ_{r_j}, radius r_j , circle $\theta_{r_{\text{h}}}$, radius r_{h} and circle $\theta_{r_{\text{d}}}$, radius r_{d} .

Body **T** moves along a trajectory, each point of which is located on intersected circles of radii r_θ (r_j , r_d , r_e . . .), around the center of rotation.

Let us record the force $\vec{F}_{\text{T}}$, applied to the body **T** with mass **m**, moving along a curvilinear trajectory

$$\vec{F}_{\text{T}} = \text{m}\vec{a}_{\text{T}} \qquad (1)$$

$\vec{a}_{\text{T}}$ – variable acceleration of body **T** of mass **m** moving between circles θ_r.

We record the speed $\vec{v}_{\text{T}}$ of the body **T**, moving along a curved trajectory, moving between circles θ_r, of radii r_θ (r_j , r_d , r_e . . under the action of a variable force $\vec{F}_{\text{T}}$, (1) **, Fig. 2.**

On each of the intersected circles θ_r of radii r_θ (r_j , r_d , r_e . . .), the body **T** will move with variable velocities $\vec{v}_{\text{T}}$.

$$\vec{v}_{\text{T}} = \vec{\omega}_r \cdot \vec{r}_\theta \qquad (2)$$

$\vec{\omega}_r$ – variable angular velocity applied to body **T** by intersected circles θ_r,

of radii r_θ (r_j , r_d , r_e . . .).

$\vec{r}_\theta$ – variable radii r_θ (r_j , r_d , r_e . . .) of θ_r circues.

Let us record the variable acceleration $\vec{a}_{\text{T}}$ of the body **T** of mass **m** moving along a curvilinear trajectory from the power center.

$$\vec{a}_{\text{T}} = \frac{d\vec{v}_{\text{T}}}{dt} = \frac{d\,\vec{\omega}_r \cdot \vec{r}_\theta}{dt} \qquad (3)$$

The variable acceleration $\vec{a}_{\text{T}}$ of the body **T** depends on two variables: the variable angular velocities $\vec{\omega}_r$ of the intersected circles θ_r and the variable radii of these circles r_θ.

The acceleration value $\vec{a}_{\text{T}}$ is calculated in partial derivatives.

$$\vec{a}_{\text{T}} = (\vec{\omega}_r \cdot \vec{r}_\theta)' = \vec{\omega}_r \frac{d\vec{r}_\theta}{dt} + \vec{r}_\theta \frac{d\vec{\omega}_r}{dt} \qquad (4)$$

Let's substitute the acceleration $\vec{a}_{\text{T}}$, formula (4), into the force formula $\vec{F}_{\text{T}}$, formula (1).

$$\vec{F}_{\text{T}} = \text{m}(\vec{\omega}_r \frac{d\vec{r}_\theta}{dt} + \vec{r}_\theta \frac{d\vec{\omega}_r}{dt}) = \text{m}(\vec{\omega}_r \vec{v}_{\vec{r}_\theta} + \vec{r}_\theta \vec{\varepsilon}_r) = \text{m}(\vec{a}_{\vec{r}_\theta} + \vec{a}_{\theta_r}) = \text{m}\,\vec{a}_{\vec{r}_\theta} + \text{m}\,\vec{a}_{\theta_r} = \vec{F}_{\vec{r}_\theta} + \vec{F}_{\theta_r} \qquad (5)$$

$\vec{a}_{\vec{r}_\theta} = \vec{\omega}_r \vec{v}_{\vec{r}_\theta}$ – variable radial acceleration of body **T** between circles θ_r

of variable radii r_θ. The process of moving body **T** between of

circles θ_r describe the radius - vectors $\vec{r}_\theta$. Physical

the meaning of acceleration $\vec{a}_{\vec{r}_\theta}$ is to transfer the variable angular velocity $\vec{\omega}_r$

by the variable radial velocity $\vec{v}_{r_\theta}$.

$\vec{\varepsilon}_r$- variable angular acceleration of body **T** when moving around the force center

along the circles of radii *r*.

$\vec{a}_{\theta_r} = \vec{r}_\theta \vec{\varepsilon}_r$ – the orbital acceleration of body **T** when moving along circles θ_r of

alternating radii $\vec{r}_\theta$ with variable angular acceleration $\vec{\varepsilon}_r$.

$\vec{F}_{\vec{r}_\theta} = \text{m}\,\vec{a}_{\vec{r}_\theta}$ – variable radial force, moving body **T** between circles θ_r of variable radii

$\vec{r}_\theta$ (radial, centrifugal component). Force $\vec{F}_{\vec{r}_\theta}$ is a centrifugal force. Modern

mechanics denies the existence of centrifugal force and calls it fictitious.

$\vec{F}_{\theta_r}$ = m $\vec{a}_{\theta_r}$ – variable orbital force, moving body **T** along circles θ_r of variable radii *r (*orbital component).

The variable force $\vec{F}_{\mathrm{T}}$ is the only force moving the body **T** relative to the force center **O**.

As a result of the action of a single central force, a force $\vec{F}_{\mathrm{T}}$ is applied to body **T.**

Force $\vec{F}_{\mathrm{T}}$ is conventionally decomposed into components, $\vec{F}_{r_\theta}$ и $\vec{F}_{\theta_r}$.

From formula (5) follows: the body **T** moves accelerated under the action of the force $\vec{F}_{\mathrm{T}}$ along the rod with radial acceleration $\vec{a}_{\vec{r}_\theta}$. Simultaneously with radial acceleration, the body **T** moves under the action of the force $\vec{F}_{\mathrm{T}}$ with orbital acceleration $\vec{a}_{\theta_r}$ along a curvilinear trajectory around the force center, **Fig. 2.**

Thus, the force $\vec{F}_{\mathrm{T}}$ applied to the body **T** is decomposed into projections: radial (centrifugal) force $\vec{F}_{r_\theta}$ and tangent (orbital)) $\vec{F}_{\theta_r}$.

At any point of the curved path, the force $\vec{F}_{\mathrm{T}}$, applied to body **T** is directed at an angle **α** to the tangent of the circle at that point, for example, to point ***j*** of **Fig. 2.**

The force $\vec{F}_{\mathrm{T}}$ is the sum of the centrifugal force, directed radially from the center of rotation of the body T and the orbital force, directed tangentially to the circle at a given point, formula (5), **Fig. 2**.

To prove the absence of centripetal force and, therefore, centripetal acceleration, when the body **T** moves around the circle, it is enough to break the connection of the body **T** with the force center.

Body **T** will not move to the power center, but from the power center under the influence of centrifugal force.

Modern mechanics unprovenly denies the real existence of centrifugal force during the rotational movement of a body, calling it a "seeming" force and unprovenly introduces the centripetal force and centripetal acceleration.

2. We place the limiter of the movement of the body **T** along the rod at the point "**a**." Body **T**, moving along the rod, will stop at point "**a**" of **Fig. 3.**

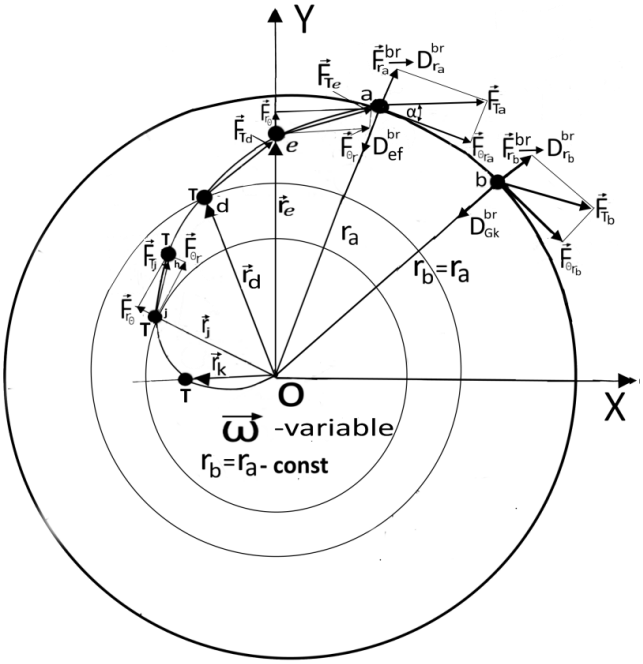


Figure 3
The scheme of movement of body T around the force center at variable radius r to point "a" and constant radius r of the point after "a" and variable angular velocity ω

At point "**a**", body **T** will put pressure on the limiter and stop moving radially along the rod. The body **T** will continue to move along the circle θ_{r_a} of radius $\boldsymbol{r_a}$ under the action of the orbital force $\vec{F}_{\theta_{r_\mathrm{a}}}$.

Let's call the radial force applied to the body **T** - a braked force and denote by the symbol $\vec{F}_{r_\mathrm{a}}^{br}$.

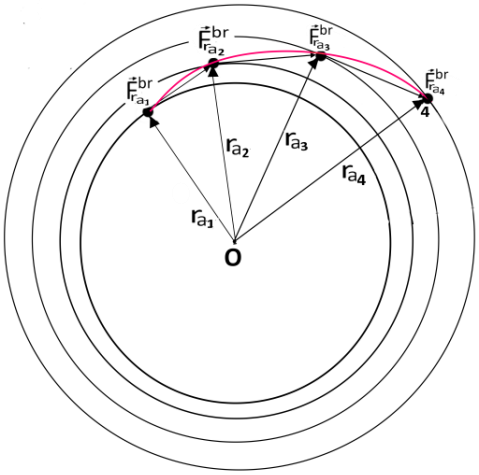


Figure 4
Movement of body T with variable angular velocity on the extensible ligament

To prove that the braked force $\vec{F}^{br}_{r_a}$ is a variable value, we replace the inextensible rod with an

extensible ligament, for example, with a spring ligament, **Fig. 4.**

Under the action of the braked force $\vec{F}^{br}_{r_a}$ the spring bundle will stretch and the body **T** moving along the circle of radius r_{a_1} will move to the circle of radius $\boldsymbol{r_{a_2}}$, then move to the circle of radius r_{a_3}, and so on.

The radial movement of the body **T** on the extensible ligament is associated with an increasing inhibited force $\vec{F}^{br}_{r_a}$.

The inhibited force $\vec{F}^{br}_{r_a}$ will create pressure on the limiter. Denote the pressure on the limiter by the symbol $\vec{D}^{br}_{r_a}$ **, Fig. 3.**

$$\vec{F}^{br}_{r_a} \rightarrow \vec{D}^{br}_{r_a} \quad (6)$$

The kinetic energy of the motion of the body **T** is converted into the potential energy of the inhibited body **T** at point **"a."**

The pressure $\vec{D}^{br}_{r_a}$ deforms the body of the rigid ligament, and the resulting elastic force counteracts this deformation.

Denote the elastic force by the symbol $\vec{D}^{br}_{ef}$. According to the third law of mechanics, the action is equal to the reaction pressure $\vec{D}^{br}_{r_a}$ is directed from the center of rotation of the body **T**, and the compensating reaction $\vec{D}^{br}_{ef}$ is directed to the center of rotation.

$$\vec{D}^{br}_{r_a} = -\vec{D}^{br}_{ef} \quad (7)$$

It should be noted that the action of the elastic force occurs only as a reaction to the action of the centrifugal force. The action directed to the center (elastic force) is secondary to the centrifugal force. In the absence of centrifugal force cannot arise centripetal force and centripetal acceleration.

Thus, the elastic force $\vec{D}^{br}_{ef}$ compensates for the pressure $\vec{D}^{br}_{r_a}$ in the rod.

Consequently, body **T** will move along a circle $\theta_{\vec{r}_a}$ of radius r_a under the action of only the orbital force $\vec{F}_{\theta_{r_a}}$.

Since the orbital force $\vec{F}_{\theta_{\vec{r}_a}}$ and the inhibited force $\vec{F}^{br}_{r_a}$ are applied to the body T moving in a circle, therefore, the resultant force $\vec{F}_{T_a}$ is applied to the body T directed at an angle to the tangent at any point "a", "b", etc. of the circle **Fig. 3.**

The force $\vec{F}_T$ will be equal to the sum of the orbital force $\vec{F}_{\theta_{\vec{r}_a}}$ and the inhibited force $\vec{F}^{br}_{\vec{r}_a}$ and directed at an angle to the tangent circle at point **"a"** , of **Fig. 3.**

$$\vec{F}_{T_a} = \vec{F}_{\theta_{r_a}} + \vec{F}^{br}_{r_a} \quad (8)$$

The direction of force, velocity and acceleration applied to a body **T** moving in a circle under the action of a variable force $\vec{F}_{T_a}$, is always directed at an angle to the tangent of the circle at a given point, for example at point **"a."**

Let's use formula (5).

$$\vec{F}_{T_a} = m(\vec{\omega}_{r_a} \frac{d\vec{r}_a}{dt} + r_a \frac{d\vec{\omega}_{r_a}}{dt}) = m(\vec{\omega}_{r_a} \vec{v}^{br}_{\vec{r}_a} + r_a \vec{\varepsilon}_{r_a}) = m(\vec{a}^{br}_{r_a} + \vec{a}_{\theta_{r_a}}) = m\,\vec{a}^{br}_{r_a} + m\,\vec{a}_{\theta_{r_a}} =$$

$$= (\vec{F}^{br}_{r_a} \rightarrow \vec{D}^{br}_{r_a}) + \vec{F}_{\theta_{r_a}} \quad (9)$$

Since the radius $\vec{r}_a$ is constant, therefore, the radial velocity $\vec{v}^{br}_{\vec{r}_a}$ is zero.

$$\frac{d\vec{r}_a}{dt} = \vec{v}^{br}_{\vec{r}_a} = 0 \quad (10)$$

The body **T** will stop moving in the radial direction.

The first term of equation (9) becomes zero.

$$\vec{\omega}_{r_a} \frac{d\vec{r}_a}{dt} = 0 \quad (11)$$

Examine the second term of equation (9). The angular velocity $\vec{\omega}_{r_a}$ of the motion of the body **T** is a variable.

Let's write down the angular acceleration.

$$\frac{d\vec{\omega}_{r_a}}{dt} = \vec{\varepsilon}_{r_a} \quad (12)$$

The body **T** will move along a circle of θ radius r_a with angular acceleration $\vec{a}_{\theta r_a}$ under the influence of a variable orbital force $\vec{F}_{\theta r_a}$.

Taking into account the current variable pressure $\vec{D}^{br}_{r_a}$, formula (9) will be written as:

$$\vec{F}_{T_a} = (\vec{F}^{br}_{r_a} \rightarrow \vec{D}^{br}_{r_a}) + \vec{F}_{\theta r_a} \quad (13)$$

Thus, by increasing the force $\vec{F}_{T_a}$ of the driving body **T** along a circle of constant radius $\boldsymbol{r}_a$, the body **T** will:

- be accelerated under the action of only the orbital variable force $\vec{F}_{\theta \vec{r}_a}$ around the center "O."

- create increasing braked, centrifugal force $\vec{F}^{br}_{\vec{r}_a}$, which forms an increasing pressure $\vec{D}^{br}_{\vec{r}_a}$, directed from the center "O."

- as a result of increasing pressure $\vec{D}^{br}_{\vec{r}_a}$, increasing elastic force $\vec{D}^{br}_{ef}$ is created in the rod.

So, the forcibly stopped body **T** at the point **"a"** of the rod will be accelerated along a circle of constant radius r_a, under the action of only the orbital force $\vec{F}_{\theta \vec{r}_a}$, create a variable centrifugal braked force $\vec{F}^{br}_{\vec{r}_a}$, creating pressure $\vec{D}^{br}_{\vec{r}_a}$ in the rod.

Conclusion.

When body **T** moves along a curved trajectory, body **T** is affected by the force $\vec{F}_T$, directed at an angle to the tangent at any point in the trajectory of body **T**.

3.We study the process of rotation of the body T around the force center "O" along the circle θ_{r_a} of constant radius r_a with constant angular velocity $\vec{\omega}_{r_a}$ at any point of the circle, for example, at point **"a", Figure 5:**

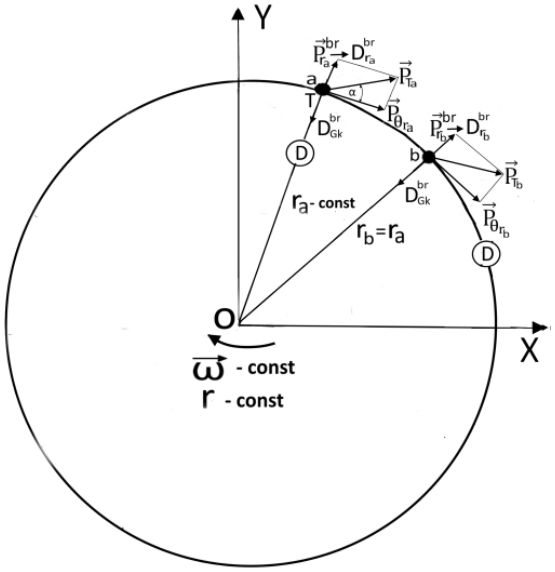


Fig.5
Diagram of body T motion around force center at constant radius r and constant angular velocity ω

The orbital velocity $\vec{v}_{r_a}$ of the body T will be constant, equal to:

$$\vec{v}_{r_a} = \vec{\omega}_{r_a} r_a = \text{const} \quad (14)$$

The orbital momentum is constant.

$$\vec{P}_{r_a} = m\vec{\omega}_{r_a} r_a = m\vec{v}_{r_a} \quad (15)$$

The inhibited radial momentum is a constant value.

$$\vec{P}^{br}_{r_a} = \text{конст.} \quad (16)$$

A resultant pulse will be applied to the body, which is the sum of the radial inhibited pulse $\vec{P}^{br}_{r_a}$ and the orbital pulse P_{r_a}.

A constant momentum $\vec{P}_{T_a}$, directed at an angle to the tangent at point **"a"** will be applied to body T.

$$\vec{P}_{T_a} = \vec{P}^{br}_{r_a} + P_{r_a} \quad (17)$$

We prove that a constant momentum acts on the body T, directed at an angle to the tangent at any point of the circle.

To prove, we will integrate the first dynamometer into the rod for measuring the braked pulse $\vec{P}^{br}_{r_a}$, with the second dynamometer we will measure the orbital pulse $\vec{P}_{\theta \vec{r}_a}$ during the movement of the body T around the force center.

Under these conditions, the value of the braked centrifugal pulse $\vec{P}^{br}_{r_a}$ will cease to change in value and become a constant value, **Fig. 5.**

The inhibited constant pulse $\vec{P}^{br}_{r_a}$ creates a constant pressure $\vec{D}^{br}_{a}$ on the limiter**, Fig. 5.**

$$\vec{P}^{br}_{r_a} \rightarrow \vec{D}^{br}_{\vec{r}_a} \quad (18)$$

As a result of the pressure on the limiter $\vec{D}^{br}_{a}$ **, Fig. 4**, an elastic force $\vec{D}^{br}_{ef}$ will arise in the rod, compensating for the pressure $\vec{D}^{br}_{\vec{r}_a}$:

$$\vec{D}^{br}_{a} \rightarrow \vec{D}^{br}_{Gk} \quad (19)$$

When body T rotates around the force center under the action of constant pulse $\vec{P}_{T_a}$, dynamometers will

show constant values of braked centrifugal pulse $\vec{P}_{\mathrm{T_a}}$, and orbital pulse $\vec{P}_{\theta_{\vec{r}_\mathrm{a}}}$.

The sum of constant pulses $\vec{P}_{r_\mathrm{a}}^{br}$ and $\vec{P}_{\theta_{\vec{r}_\mathrm{a}}}$ forms a resultant pulse $\vec{P}_{\mathrm{T_a}}$.

$$\vec{P}_{r_\mathrm{a}}^{br} + \vec{P}_{\theta_{\vec{r}_\mathrm{a}}} = \vec{P}_{\mathrm{T_a}} \quad (20)$$

The direction of the resultant momentum $\vec{P}_{\mathrm{T_a}}$, velocity and acceleration are always directed at an angle **α** to the tangent of the circle at a given point, for example, at points **"a"** or **"b."**

Determine the **α** angle for a given pulse value $\vec{P}_{\mathrm{T_a}}$, **Fig. 5.**

$$\mathrm{tg}\alpha = \frac{\vec{P}_{r_\mathrm{a}}^{br}}{\vec{P}_{\theta_{\vec{r}_\mathrm{a}}}} \quad (21)$$

$$\alpha = \mathrm{arctg}\,\frac{\vec{P}_{r_\mathrm{a}}^{br}}{\vec{P}_{\theta_{\vec{r}_\mathrm{a}}}} \quad (22)$$

Knowing the angle **α** you can determine the momentum $\vec{P}_{\mathrm{T_a}}$, applied to the body T, rotating the body T around the force center.

In the case under study, when body T moves in a circle without acceleration, formula (13) will be written in the form:

$$\vec{P}_{\mathrm{T_a}} = (\vec{P}_{r_\mathrm{a}}^{br} \rightarrow \vec{D}_{r_\mathrm{a}}^{br}) + \vec{P}_{\theta_{r_\mathrm{a}}} \quad (23)$$

The only impulse $\vec{P}_{\mathrm{T_a}}$, applied to the body T creates:

- constant orbital pulse $\vec{P}_{\theta_{\mathrm{r_a}}}$, which uniformly moves the body T along circles $\theta_{\vec{r}_\mathrm{a}}$ of radius $\vec{r}_\mathrm{a}$ around force center "O."
- constant inhibited centrifugal and pulse $\vec{P}_{\vec{r}_\mathrm{a}}^{br}$, which creates the constant pressure $\vec{D}_{\vec{r}_\mathrm{a}}^{br}$, directed from the center "O."
- constant elastic force $\vec{D}_{ef}^{br}$ created by constant pressure $\vec{D}_{\vec{r}_\mathrm{a}}^{br}$.

Pulse $\vec{P}_{\mathrm{T_a}}$ applied to a body T moving along a circle of constant radius has two projections: constant orbital pulse $\vec{P}_{\theta_{r_\mathrm{a}}}$ and constant inhibited radial, centrifugal pulse $\vec{P}_{\vec{r}_\mathrm{a}}^{br}$.

With uniform movement of body T along the circle without acceleration, a constant momentum directed at an angle to the tangent at any point of the circle is applied to body T.

Conclusion

1. When a body moves along a curved trajectory, including along a circle, a force or momentum acts on body T at an angle to the tangent at any point in the trajectory of the body.
2. The momentum or force moving the body along the curvilinear trajectory creates a radial, centrifugal, momentum or force and elastic force in the bundle, compensating for the inhibited centrifugal momentum $\vec{P}_{\vec{r}_\mathrm{a}}^{br}$.
3. In none of the three studied cases of movement of body T along a curvilinear trajectory, including along a circle, there is no centripetal acceleration and centripetal force.
4. The action of the elastic force occurs only as a reaction to the action of centrifugal force or centrifugal pulse. The action directed to the center (elastic force) is secondary to the centrifugal force or centrifugal pulse. In the absence of centrifugal force or centrifugal momentum, centripetal force and centripetal acceleration cannot occur.
5. When the connection with the power center is broken, the body T will move from the power center under the influence of centrifugal force, proving the absence of centripetal force and centripetal acceleration.
6. The body T moves in a circle under the action of only one constant orbital pulse $\vec{P}_{\theta_{r_\mathrm{a}}}$.

POLITICAL SCIENCES

PUBLIC SCHOOL IN THE DIGITAL AGE

Khatuna Nebieridze
Academic Supervisor: Giorgi Momtselidze
Grigol Robakidze University
DOI: 10.5281/zenodo.20609809

Abstract

This article examines the transformation of public school governance under the conditions of the digital age and shows that technological change is no longer merely an instrumental issue for schools. The digital environment changes the logic of school governance, the pace of decision-making, the forms of accountability, the channels of communication, the practices of using data, and the professional role of school leadership. The aim of the paper is to identify the characteristics that distinguish public school governance in the digital age, to determine what opportunities it creates in terms of teaching and learning quality, administrative efficiency, and transparency, and to reveal what risks it generates in relation to inequality, excessive bureaucratisation, data security, and the weakening of the human factor. The article is based on an analytical-review study; comparative analysis, document analysis, and synthesis were used. The study analyses Georgian educational policy documents, as well as contemporary works by UNESCO, the OECD, and the World Bank on digital transformation, educational leadership, and school governance. The study argues that effective digital governance is not equivalent to mere computerisation. Its essence lies in turning the school into a data-driven, flexible, ethically responsible, and collaborative institution in which technology serves pedagogical goals rather than the other way around. It was determined that five components are critically important for a public school: leadership with a digital vision; reliable infrastructure; clear rules for data governance; continuous professional development for teachers and administrators; and an inclusive policy that reduces digital inequality. In the Georgian context, special importance is attached to systemic consistency, because partial implementation of digital tools in school governance cannot produce sustainable results unless it is accompanied by the renewal of organisational culture, responsibilities, assessment, and support mechanisms. The concluding section of the article presents recommendations for strengthening the model of digital school governance. It is shown that a successful digital school is not the most technologised one, but the one that uses technology for human-centred, fair, and results-oriented governance.

Keywords: public school, school governance, digital transformation, educational leadership, data-driven management, digital inequality, cybersecurity

1. Introduction

Over the last decade, public school governance has faced changes that cannot be explained by administrative reform alone. The digital age has transformed the forms of social interaction, the speed of information flow, citizens' expectations regarding institutional transparency, and even the very rules of knowledge production. In this context, the school is no longer merely an organisation that delivers the curriculum; it becomes an open, data-rich, multi-actor space in which everyday governance must respond to pedagogical, technological, legal, and ethical requirements alike.

The spread of digital technologies has set two interrelated tasks before the education system. The first is the effective use of digital means in the teaching-learning process. The second, which is often less visible but no less important, involves reconsidering the model of school governance: how decisions are made, how data are stored and processed, through which channels communication with parents takes place, how professional development is planned, how the use of resources is controlled, and how results are evaluated. OECD studies on digital education policy show that digital transformation is successful when it encompasses the entire educational ecosystem and is not limited to the provision of individual devices (OECD, 2025; OECD, 2026).

For school governance, the digital age became particularly relevant after the pandemic, when it became clear that many schools used technology episodically rather than as a strategic resource. This period demonstrated that, in times of crisis, only those schools maintained governance resilience where digital communication channels existed, responsibilities were clearly distributed, teachers were supported through flexible mechanisms, and rapid decisions were based on data. The World Bank emphasises that digital transformation in education produces results when it addresses infrastructure, human capital, governance, and accountability equally (World Bank, 2024a; World Bank, 2025).

For Georgia, the issue is additionally important for several reasons. On the one hand, schools face the task of improving quality, accessibility, and equality. On the other hand, state policy already speaks about the digital renewal of the education system, including the development of technologies, data systems, and modern governance practices in general education (Ministry of Education, Science and Youth of Georgia, 2022). Third, assessments of the digital readiness of Georgia's education system indicate that, alongside progress, infrastructural, governance-related, and skills-based barriers remain, and these are directly linked to the quality of school governance (World Bank, 2024b).

The research problem lies in the fact that the digital development of public schools is often understood narrowly - as a matter of technical equipment, electronic journals, or online learning. In such an approach, the substantive transformation of school governance moves into the background. As a result, a school may possess technology but lack the digital vision, procedures, ethical standards, and leadership practices that make that technology meaningful.

The aim of the paper is to analyse the characteristics of public school governance in the digital age, identify its main components, opportunities, and risks, and assess governance priorities relevant to Georgia. The object of the study is public school governance, while the subject of the study is the transformation of the governance model under conditions of digital transformation. The objectives of the study are to define the theoretical foundations of school governance in the digital age; identify the components of effective digital governance; analyse the main challenges on the basis of international and Georgian documents; and formulate recommendations for public schools.

The article uses an analytical-review design. The main methods are document analysis, comparative analysis, and theoretical synthesis. The research source base includes both national normative and strategic documents and the latest studies by international organisations dealing with educational leadership, digital policies, and school governance. This approach makes it possible, on the one hand, to see the conceptual framework and, on the other hand, to identify findings that can be used in Georgian schools in practice.

2. Conceptual Foundations of Public School Governance in the Digital Age

The theoretical understanding of school governance largely rests on the question of what a school is as an organisation. In the traditional approach, the school was viewed as a hierarchical institution in which the centre of governance is the principal and higher authorities, while the lower level is mainly oriented toward execution. The digital age partially changes this model, because the rapid circulation of information and decentralised communication increase the importance of distributing responsibility within the school. This does not mean the abolition of hierarchy; rather, it is more accurate to say that effective governance becomes networked, collaborative, and more process-oriented.

UNESCO's report on leadership emphasises that contemporary educational leadership can no longer be confined to administration alone; it includes creating vision, managing human relations, leading change, and making decisions adapted to the local context (UNESCO, 2024). The digital age adds a new dimension to this vision. The principal must be not only an organiser but also an architect of change who connects technology to school goals, professional development, data ethics, and civic responsibility.

One of the foundations of digital governance is data-driven management. Every day, schools accumulate information about attendance, academic achievement, assessment, behaviour, resource use, communication, and professional needs. However, the mere existence of data does not in itself create high-quality governance. For this, data must be reliable, timely, interpretable, and meaningfully integrated into the decision-making process. Thus, digital governance means not only collecting data but also using them thoughtfully to improve the school.

A second conceptual foundation is distributed leadership. In a digital environment, it is difficult for one person to control all processes, because pedagogical, technological, administrative, and communicative activities take place simultaneously within the school. Therefore, a successful school creates governance practices in which the principal, deputy principals, heads of subject departments, technical staff, and teachers' professional groups function as an interdependent system. Distributed leadership increases organisational resilience and reduces the risks associated with dependence on one individual.

The third foundation is the theory of public values. A public school operates not only according to the principles of efficiency, but also according to justice, equality, participation, and accountability. Digital tools sometimes strengthen these values and sometimes endanger them. For example, electronic communication increases transparency and parental involvement, but poor data protection may compromise student confidentiality. Therefore, digital governance in public schools should be based not on technological enthusiasm but on a value framework that clearly defines why technology is used and what its limits are.

In this context, it can be said that the school of the digital age is a hybrid organisation: it is simultaneously an educational, administrative, informational, and ethical system. Its effective governance requires the synthesis of different fields - pedagogy, management, law, data security, and organisational culture. It is precisely this synthesis that distinguishes deep digital transformation from superficial technologisation.

The differences presented in the table show that digital governance is not simply the addition of new tools to an old organisation. It changes the rhythm of processes, the distribution of responsibilities, and the form of accountability. At the same time, the digital model is justified only when the school succeeds in managing its risks in advance.

Table 1.

Comparative features of traditional and digital governance in public schools

Governance Aspect	Traditional Model	Digital Age Model
Information flow	Mainly top-down, slow, and paper-based	Multi-channel, fast, platform-supported, and feedback-oriented
Decision-making	Separated and often intuitive	Data-driven, relatively fast, and team-based
Accountability	Dependent on formal reports	Possibility of real-time monitoring and transparent documentation
Leadership	Highly concentrated in the principal	Distributed leadership and networked coordination of functions
Communication with parents	Episodic meetings and paper notices	Electronic channels, rapid feedback, and documented communication
Risks	Loss of information; slow response	Data security, overload, digital inequality

3. The Impact of the Digital Age on the Main Functions of Public School Governance

Public school governance includes several core functions: strategic planning, coordination of human resources, support for the teaching-learning process, communication, resource allocation, monitoring, and accountability. The digital age changes each of these functions differently, yet the overall trend is the same: governance becomes more integrated, transparent, and data-oriented.

At the level of strategic planning, the digital environment forces schools to think in advance not only about educational goals but also about technological sustainability. The principal and the governing team need a digital vision that answers questions such as: What role does technology play in achieving school goals? What are the priorities for infrastructure development? What skills do teachers need? How is progress assessed? According to the OECD, the effectiveness of national and school policy increases when digital policy is not separate, but integrated into the overall school development plan (OECD, 2025).

Human resource management in the digital age is no longer limited to distributing workloads and formal supervision. It includes identifying professional development needs, organising collaboration through digital platforms, supporting teachers in digital pedagogy, and documenting work processes. School governance must be able to manage resistance to technological change not through punishment but through support. Otherwise, technology becomes a means of administrative pressure rather than professional empowerment.

In terms of supporting the teaching-learning process, governance increasingly relies on platforms, electronic resources, assessment data, and the possibility of distance or hybrid learning. This means that the competence of the principal and the governing team must go beyond the boundaries of classical office administration. They must understand how technology is connected to teaching quality, student engagement, and support for children with diverse needs.

In the sphere of communication, digital tools have enabled public schools to interact more quickly with parents, students, and teachers. However, the speed of communication does not always mean an increase in its quality. Unplanned messages, excessive information flow, and non-uniform channels often lead to confusion. Therefore, digital governance requires a communication policy: which issue is transmitted through which channel, who is responsible for responding, within what timeframe, and how the communication trail is preserved.

In the area of monitoring and accountability, digital systems create the possibility for a school to identify problems promptly - declining attendance, changes in learning outcomes, lateness, inefficient use of resources, or shortcomings in professional development. Yet the expansion of quantitative monitoring is accompanied by a qualitative danger as well: there is a risk that governance will turn into the mere control of numbers and lose pedagogical depth. Thus, school governance needs a balance between measurable indicators and professional judgement.

4. Digital Leadership, Organisational Culture, and Change Management

In the digital age, one of the most frequently discussed issues is the new role of the principal and the school leadership team. Technical competence alone is not enough. Digital leadership implies a vision that technology serves the school's mission; the ability to involve different groups - teachers, students, parents, and technical staff - in the process of change; and the determination to ensure that reform does not become a one-time project. Recent UNESCO and World Bank materials show that systemic digital transformation is firmly linked to the quality of leadership and not merely to the volume of resources (UNESCO, 2025; World Bank, 2024a).

The practical manifestation of digital leadership can be seen at several levels. The first is determining strategic significance: the principal must explain why a particular digital change is necessary and what result it will bring. The second is motivating and supporting staff: change encounters less resistance when teachers feel that technology improves their work rather than simply increasing reporting burdens. The third is modelling: the governing team itself must use digital tools purposefully so that trust and consistency are established in the school culture.

Organisational culture is a critical dimension of digital governance. The same technological resource has different effects in different schools because the

quality of collaboration, trust, attitudes toward mistakes, and the culture of professional learning differ. If digital innovation is perceived in a school as a tool of surveillance, staff often achieve only formal compliance. But if it is perceived as a means of common development, initiative, knowledge-sharing, and shared responsibility increase.

The theory of change management suggests that reform is rarely successful through command alone. For digital transformation in schools, phased planning is important: assessing the current situation, defining goals, identifying needs, piloting, collecting feedback, making adjustments, and scaling up. In the Georgian school reality, this means that the principal must simultaneously manage high expectations and a realistic pace. Change that is too rapid creates professional stress; change that is too slow loses motivation and diminishes results.

Therefore, digital leadership may be regarded as an integrative competence. It combines administrative order, pedagogical vision, human communication, and technological awareness. Without such leadership, a digital school can easily turn into technical infrastructure lacking governance meaning.

5. Data Governance, Cybersecurity, and Ethical Responsibility

One of the most sensitive directions of public school digital governance is data governance. Schools collect information related to minors, family environments, academic progress, certain health data, attendance, and behaviour. Consequently, digital transformation inevitably raises questions: who has access to data, for what purpose they are stored, for how long, in what format, and under what conditions they are shared.

Data governance is not merely a technical issue. It is also a governance issue, because the absence of rules increases both legal and ethical risk. Schools should have clear procedures for data minimisation, levels of access, backups, password protection, official communication, and response to incidents. When such procedures are vague, a digital system may become a source of vulnerability instead of efficiency.

The problem of cybersecurity is especially relevant when a school uses multiple platforms - electronic journals, communication apps, cloud storage, video conferencing tools, and online assessment forms. Fragmentation of platforms often increases the risk of data leakage, improper sharing, and loss of information. Accordingly, public school governance needs a principle: fewer systems, but better-managed ones.

The issue of ethical responsibility goes beyond technical security standards. For example, in data-driven assessment, the school must take into account that a numerical indicator never fully reflects a child's abilities or social context. It is also important that digital monitoring does not turn into permanent surveillance that harms trust and autonomy. For this reason, contemporary discussions increasingly focus on human-centred digital governance, in which data are a supporting resource rather than an end in themselves.

In this respect, at least three conditions are necessary for public schools: basic training of staff in digital ethics; internal school rules governing data use; and informing parents and students of their rights and responsibilities. In such a case, digital governance gains legitimacy and is not viewed as an opaque control system.

6. Digital Inequality, Inclusion, and the Social Mission of Public Schools

The digital age simultaneously creates opportunities and intensifies inequality. For public school governance, this means that every technological decision should be assessed through the lens of social justice. Not every student, teacher, or family has equal access to the internet, devices, digital skills, or a calm learning environment. Therefore, digital governance cannot be successful if it is designed only for groups with average or best conditions.

The works of the World Bank and other international organisations make it clear that the most vulnerable groups in digital education reforms are often rural children, members of socially vulnerable families, students with special educational needs, and teachers with less prior digital experience (World Bank, 2024b; UNESCO, 2024). Consequently, digital transformation for public schools should be compensatory rather than neutral: it should seek to reduce differences.

Inclusive governance requires schools to ask several practical questions when making technological decisions: Who will be left out? Which group will not be able to use the system independently? Does the platform need an adapted version? How is information delivered to parents who find digital communication difficult? Is there an alternative channel? Such questions show that digital governance is, in reality, also a matter of social policy.

The social mission of the public school is particularly visible in the way it manages the fair distribution of resources. In one school there may be a common pool of devices, a laboratory schedule, support for children with special needs, teacher mentoring, and information meetings for parents. In another school, the same technology may be only a formal project. The difference is created precisely by governance vision: do we view technology as an attribute of prestige or as an instrument of equality?

Therefore, it may be said that a digital public school fulfils its mission only when technological development is aligned with the school's ethos - no group is left unattended, and different needs are recognised as a central rather than secondary matter of governance.

7. The Georgian Context: Opportunities and Systemic Barriers of Digital Governance

In recent years, Georgian educational policy has more clearly emphasised the digital renewal of the education system. The Unified National Strategy for Education and Science 2022-2030 links technological development both to quality improvement and to better governance, accessibility, and the creation of an innovative environment (Ministry of Education, Science and Youth of Georgia, 2022). This indicates that digital school governance is already perceived at the policy level as a systemic task.

At the same time, the World Bank's digital readiness assessment of Georgia's education system shows that the country has both progress and significant shortcomings. The report draws attention to infrastructure,

digital skills, governance and regulations, and the need for coordination between different levels of the system (World Bank, 2024b). This is a particularly important conclusion, because public school governance often loses effectiveness precisely due to a deficit of coordination: the school receives a tool, but not sufficient support, guidance, or integrated policy.

In the Georgian reality, one of the main challenges is unequal conditions among schools. Urban and rural schools, large and small schools, centre and periphery schools have different resources and support. In such circumstances, imposing uniform digital requirements creates only partial results. A differentiated approach is needed that takes into account the school's size, infrastructure, staff profile, and social context.

A second challenge relates to professional development. In practice, digital transformation programs often concentrate on basic training in the use of tools, whereas the quality of governance requires deeper competence: reading and interpreting data, managing hybrid communication, digital ethics, preventing cybersecurity incidents, and change management. The professional development of principals and administrators in this area is as important as teacher preparation.

A third challenge is the fragmentation of tools. When a school uses multiple applications for different purposes and the links among them are weak, bureaucratic burden increases and system usability declines. For successful digital governance, Georgian schools need more integration, simplification of procedures, and unified standards.

Yet the opportunities are also clear. Georgia's relatively flexible education system, ongoing reforms, and cooperation with international partners create conditions for digital governance to become not a fragmented novelty but a strategic axis of school development. For this, it is important that priority at the policy level be given not only to the purchase of equipment but also to the consistent renewal of the school governance model.

8. Research Results and Analytical Synthesis

On the basis of the analytical discussion conducted, several key findings can be identified. The first finding is that public school digital governance is a multidimensional concept and cannot be reduced solely to technological infrastructure. In an effective school, digital transformation includes strategy, leadership, processes, data ethics, professional development, and the principle of social justice.

The second finding is that digital tools increase the speed and informedness of decision-making, but only if the school has a basic culture of data analysis. Otherwise, the information accumulated in the system simply becomes an administrative burden. Thus, the main concern of governance is not the quantity of data but its interpretation and usability.

The third finding concerns leadership. The analysis showed that the role of the principal in the digital age expands significantly. The principal can no longer be confined to resource allocation and disciplinary supervision; instead, the principal becomes an organiser of change, a guarantor of digital ethics, a supporter of professional learning, and a link among different stakeholder groups. Accordingly, the professional profile of school leaders should be assessed by new criteria.

The fourth finding is that technological progress does not automatically reduce inequality. On the contrary, poorly planned digital transformation often intensifies existing differences. Therefore, when assessing public school governance, it is necessary to take into account not only the existence of technology, but also its fair accessibility and usability for different groups.

The fifth finding concerns systemic consistency. School-level efforts quickly reach their limit if there is no stable policy, unified standards, reliable platforms, and purposeful support from the national or municipal level. Consequently, digital governance should be considered as a space of agreed responsibilities between the school and the system.

Based on these findings, a working model of public school digital governance may be formulated, built on five pillars: 1) digital vision and strategy; 2) leadership and professional development; 3) data governance and security; 4) inclusive access; 5) integrated monitoring and feedback. If the school leaves out any of these elements, digital transformation loses its systemic nature and becomes only partially effective.

A limitation of the study should be noted: the article is based on an analytical-review method and does not include empirical field research in specific schools. However, the diversity of the sources used and the synthesis of international and national documents make it possible to use the conclusions drawn both as an initial framework for further empirical research and for practical policy planning.

9. Recommendations for Strengthening Public School Governance

The first recommendation concerns the formation of a school-level digital vision. Each public school should have not only a list of technical needs, but also a short, clear, and measurable digital governance plan linked to the overall school development plan.

The second recommendation is the creation of a special professional development module for principals and governing teams. This module should emphasise data-driven management, principles of digital ethics, security, change management, and organisational communication.

The third recommendation concerns the integration of platforms. The smaller the fragmentation and the easier the connection among school data, the lower the bureaucracy and the higher the governance effectiveness. A systemic solution is needed here, not the improvisation of individual schools.

The fourth recommendation is the development of internal protocols for data governance in schools. Schools should have written rules on data collection, storage, sharing, communication with parents, and responses to cyber incidents.

The fifth recommendation concerns inclusiveness. Every step of digital policy should include an assessment of how the decision affects vulnerable groups. Where necessary, schools should provide alternative channels, additional support, and adapted resources.

The sixth recommendation is to maintain a balance in assessment. School governance should use digital indicators, but should not replace pedagogical judgement, professional dialogue, and the broad view of student development with them.

10. Conclusion

In the digital age, public school governance is transforming from instrumental administration into integrated, data-driven, and value-responsible leadership. Technology is no longer merely a supporting background; it becomes part of the governance environment that shapes communication, planning, monitoring, support for teaching, and public accountability.

The analysis in the article has shown that a digital public school is effective when technological change does not stop at equipment alone but develops into organisational transformation. Such transformation requires digital leadership, ethical data governance, continuous professional development of staff, platform integration, and an inclusive vision that reduces inequality.

In Georgia's case, the perspective of digital governance is real, although it requires more consistent political and institutional support. Schools need not only equipment but also a purposeful framework, internal procedures, a reliable data system, and continuous mechanisms of professional support. In this regard, digital governance should be considered one of the important directions for educational quality, justice, and the development of the modern state.

The scientific novelty of the paper lies in the fact that the digital development of the public school is considered not as a separate technological issue, but as a transformation of the governance model in which leadership, data policy, inclusion, and organisational culture are integrated. For further research, it is advisable to conduct empirical studies in Georgian public schools on how specific practices of digital governance affect teaching quality, staff motivation, and student outcomes.

Summary

This article examines public school governance in the digital age and argues that digital transformation should not be reduced to the provision of devices, online platforms, or isolated technical solutions. In contemporary education systems, digitalisation changes the logic of governance itself: it reshapes communication, decision-making, accountability, professional collaboration, monitoring, and the ethical handling of information. Therefore, school governance must be reconsidered as a broader organisational, pedagogical, and value-based process. The main purpose of the article is to identify the core characteristics of public school governance under digital conditions, to analyse its opportunities and risks, and to outline priorities relevant to the Georgian context. The study relies on an analytical and review-based methodology and uses document analysis, comparative analysis, and theoretical synthesis. The source base includes Georgian policy documents and legal frameworks together with recent publications by UNESCO, the OECD, and the World Bank on digital transformation, educational leadership, and school governance.

The article demonstrates that effective digital governance is built on several interrelated pillars. First, it requires digital leadership. In the digital age, a school principal is no longer only an administrator responsible for routine compliance. The principal becomes a strategic actor who connects technology to educational goals, supports teachers through change, creates a shared vision, and ensures that digital tools strengthen rather than distort the school's mission. Second, digital governance requires reliable and integrated data practices. Public schools now generate substantial information on attendance, achievement, communication, school processes, and resource use. However, data do not improve governance automatically. They must be accurate, timely, interpretable, and connected to meaningful decision-making. Third, digital governance demands clear ethical and security principles. Because schools work with sensitive information about minors and families, digital systems must be accompanied by rules on access, storage, privacy, cybersecurity, and responsible communication.

The article also highlights the importance of organisational culture. The same digital tools can have very different effects depending on levels of trust, collaboration, and professional support within a school. If technology is introduced as a control mechanism, staff often respond with formal compliance and minimal engagement. If it is introduced as a tool for pedagogical improvement and organisational learning, schools are more likely to develop initiative, shared responsibility, and sustainable innovation. In this sense, digital transformation is inseparable from change management. It should include needs assessment, staged implementation, feedback loops, and opportunities for reflection. Rapid and poorly supported digital reform may create overload, resistance, or superficial adoption.

A central argument of the article is that digital governance has a strong social dimension. Public schools cannot treat digital policies as neutral because access to devices, connectivity, and digital skills remains uneven. Rural schools, socially vulnerable families, students with special educational needs, and teachers with limited digital experience may face greater barriers. For this reason, effective public school governance must be inclusive and compensatory. Technology should function as a tool for reducing inequality rather than reproducing it. Every major digital decision at school level should therefore be assessed in terms of who benefits, who may be left behind, and what support mechanisms are needed.

In relation to Georgia, the article notes that recent strategies and policy documents increasingly recognise the importance of digital transformation in education. At the same time, analytical evidence suggests that progress remains uneven and that major challenges persist in infrastructure, skills, coordination, and governance capacity. The Georgian case shows that digital reform cannot be sustained through fragmented initiatives alone. Schools need coherent guidance, integrated platforms, targeted professional development, and stronger institutional support.

The main conclusion is that public school governance in the digital age should be understood as the

transformation of the governing model itself. Technology is valuable only when it is embedded in human-centred leadership, ethical responsibility, professional learning, inclusion, and meaningful accountability. A successful digital public school is not the one with the largest number of devices, but the one that uses digital tools to become more responsive, more just, more transparent, and more educationally effective.

References

1. Billings, D. (2024). Digital Transformation of the Public Sector and the New Logic of Governance. Universali Publishing.
2. Georgia. (2005). Law of Georgia on General Education. Legislative Herald of Georgia.
3. Ministry of Education, Science and Youth of Georgia. (2022). Unified National Strategy for Education and Science 2022-2030. https://mes.gov.ge/publicInfo/wp-content/uploads/2022/10/strategia-2022-2030.pdf
4. Ministry of Education, Science and Youth of Georgia. (2022). Action Plan of the Unified National Strategy for Education and Science 2022-2030. https://mes.gov.ge/content.php?id=13130&lang=geo
5. Boeskens, L. (2025). Policies for the digital transformation of school education: Evidence from the Policy Survey on School Education in the Digital Age. OECD Publishing. https://www.oecd.org/content/dam/oecd/en/publications/reports/2025/03/policies-for-the-digital-transformation-of-school-education_aee58b2f/464dab4d-en.pdf
6. OECD. (2023). OECD Digital Education Outlook 2023: Towards an effective digital education ecosystem. OECD Publishing. https://doi.org/10.1787/c74f03de-en
7. OECD. (2026). OECD Digital Education Outlook 2026: Exploring effective uses of generative AI in education. OECD Publishing. https://doi.org/10.1787/062a7394-en
8. UNESCO. (2024). Leadership in education: 2024/5 Global Education Monitoring Report. UNESCO. https://www.unesco.org/reports/gem-report/en/2024-leadership-education
9. UNESCO. (2025). New UNESCO report shows growing importance of school leaders as digital transformation in education speeds up. https://www.unesco.org/gem-report/en/articles/new-unesco-report-shows-growing-importance-school-leaders-digital-transformation-education-speeds
10. UNESCO. (2025). 2025 East Asia report: Leadership for digital transformation in education. https://www.unesco.org/gem-report/en/2025eastasia
11. UNESCO. (2026). The Digital Transformation Collaborative in action: Advancing system-wide digital transformation in education. https://www.unesco.org/en/articles/digital-transformation-collaborative-action-advancing-system-wide-digital-transformation-education
12. World Bank. (2024a). Digital Pathways for Education: Enabling greater impact for all. World Bank. https://openknowledge.worldbank.org/entities/publication/9673fd74-1bf4-4693-b45f-374a64464c63
13. World Bank. (2024b). Georgia Education System Digital Readiness Assessment. World Bank. https://documents1.worldbank.org/curated/en/099102424122038117/pdf/P17353010189630e192ab1f161baa8aff3.pdf
14. World Bank. (2025). Three mindset shifts to build digital and AI empowered education. https://blogs.worldbank.org/en/education/three-mindset-shifts-to-build-digital-and-ai-empowered-education
15. ETF. (2020). Digital skills and online learning in Georgia. European Training Foundation. https://www.etf.europa.eu/sites/default/files/2020-06/digital_factsheet_georgia.pdf
16. Gaible, E., Rajasekaran, S., & Kutateladze, N. (2024). Digital readiness and school-level governance in Georgia. World Bank background paper.
17. Fullan, M. (2020). Leading in a culture of change. Jossey-Bass.
18. Hargreaves, A., & Fullan, M. (2023). Professional capital after the pandemic: Revisiting educational change. Routledge.
19. Spillane, J. P. (2021). Distributed leadership. Jossey-Bass.

TECHNICAL SCIENCES

FEATURES OF THE PRACTICAL IMPLEMENTATION OF SIMULATION TECHNOLOGIES IN TEACHING ELECTRICAL ENGINEERING DISCIPLINES IN BLENDED LEARNING CONDITIONS

Berestovoi I.
Ph.D., Associate Professor of the Department "Ship Power Plants and Systems"
Danube Institute of National University "Odessa Maritime Academy," Izmail, Ukraine
DOI: 10.5281/zenodo.20609875

Abstract

This article examines the implementation of simulation technologies in teaching electrical engineering disciplines under blended learning conditions. A hybrid approach combining physical laboratory experiments with virtual simulation tools is proposed and analyzed. As a practical implementation example, the study of thyristor operation in both a simulation environment and a physical hardware setup is considered.

The research demonstrates that simulation-based learning improves understanding of theoretical concepts, increases instructional flexibility, and supports individualized learning. It also reduces dependence on expensive laboratory equipment while maintaining the quality of practical training. The results confirm the pedagogical and economic feasibility of integrating simulation technologies into technical education.

Keywords: Simulation technologies; blended learning; electrical engineering education; thyristor; virtual laboratory; semiconductor devices; interactive learning; digital education tools; engineering pedagogy; laboratory simulation.

Problem Statement. The practical implementation features of simulation technologies in teaching electrical engineering disciplines under blended learning conditions are becoming particularly relevant in the contemporary educational paradigm, which is based on the active integration of digital tools into instructional practices [1–7]. The digital transformation of society has fundamentally reshaped the educational process, providing new opportunities for interaction between participants and for the development of professional competencies, which is especially important for technical specialties [1].

Under martial law conditions in Ukraine, educational institutions face critical challenges such as infrastructure destruction and limited access to modern physical equipment, which emphasizes the need to implement the principles of technological compensation and continuity of learning regardless of students' location [2].

The use of interactive simulations and virtual laboratories has become an effective tool for creating a safe environment in which students can explore complex systems without risk to their health or expensive equipment [3].

Electrical engineering disciplines require students to develop a deep understanding of semiconductor device operation principles, where visual modeling allows abstract theoretical concepts to be transformed into comprehensible visual representations [3, 4].

Identification of Previously Unresolved Aspects of the General Problem. Despite a considerable number of scientific works addressing the theoretical aspects of digitalization, there is still a lack of concrete practical implementations of such technologies in teaching specialized disciplines [2, 4, 6, 7].

Formulation of the Aim of the Article. The aim of the study is to substantiate a methodology for the practical implementation of simulation tools based on the example of studying the operation of a thyristor under blended learning conditions.

Presentation of the Main Research Material. The practical implementation of studying thyristor operation is proposed in a hybrid format: for students attending in-person classes, circuit assembly using real physical components is provided, ensuring the necessary kinesthetic component and tangible perception of objects [1]. Considering that the cost of a basic set of electronic components for such a circuit is relatively low, this makes the laboratory practicum accessible even under conditions of limited institutional funding [3].

Simultaneously, for students engaged in distance learning or absent for valid reasons, the use of the Circuit Simulator Applet virtual simulator is introduced [8]. This tool enables real-time construction and testing of electrical circuits, operating both online via a web browser and offline after installation on a personal computer. This approach allows students to independently vary circuit parameters, evaluate system stability, and analyze current–voltage characteristics while receiving immediate feedback [3].

Assignments for laboratory work, instructions, and methodological guidelines are recommended to be hosted on distance and asynchronous learning platforms such as Google Classroom, Moodle, or Human, ensuring a unified learning management ecosystem, knowledge assessment, and communication capabilities [1, 5].

The use of simulation technologies enables the individualization of educational trajectories by adapting learning pace and task complexity to the needs of each student, thereby increasing engagement and motivation [2, 3].

Thus, the integration of physical experimentation with virtual modeling in the process of studying thyristor operation compensates for the lack of access to traditional laboratories caused by war-related security

challenges and ensures high-quality training of future specialists in accordance with the requirements of the modern labor market.

For studying the operating principle of a symmetrical thyristor (TRIAC), the following circuit is proposed, which can be constructed in the Circuit Simulator Applet virtual environment [8], Fig. 1.

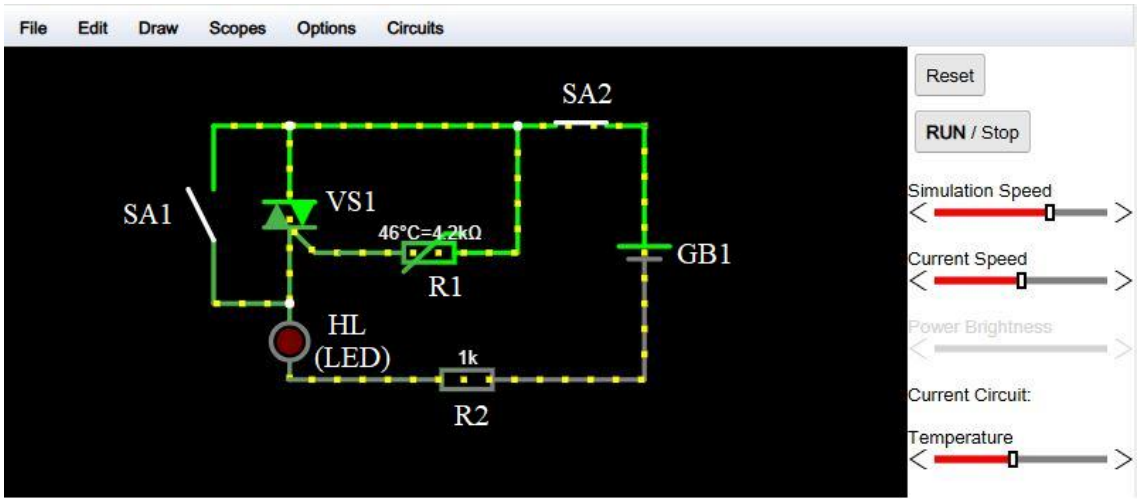


Fig. 1. Circuit for Studying the Operating Principle of a Symmetrical Thyristor

When using the simulation, the parameters of the symmetrical thyristor must be adjusted by double-clicking the TRIAC with the left mouse button and setting the Trigger Current to 1 mA and the Holding Current to 1 mA.

The considered simulation circuit demonstrates the basic operating principle of the thyristor (VS1) in a DC circuit with an active load in the form of a light-emitting diode HL (LED). The circuit includes a power supply GB1, and switch SA1, which functions as a bypass (shunting) switch intended for forced turn-off of the thyristor by short-circuiting its anode and cathode terminals. A variable resistor R1 is used to regulate the control signal parameters of the thyristor.

After the control current between the gate and cathode reaches the triggering threshold, defined by the setting of resistor R1, the thyristor switches to the conducting state and enables current flow through the load, resulting in LED illumination. Subsequent changes in the resistance of R1, either increasing or decreasing, do not affect the conducting state or cause turn-off of the device.

Switch SA1 shunts the anode and cathode of thyristor VS1, reducing the current below the holding current threshold. This forces the thyristor to transition from the conducting state to the blocking state. The model effectively illustrates the “latching” effect of the thyristor and the dependence of its operation on the holding current.

Conclusions. The study confirms that the implementation of simulation technologies in teaching electrical engineering disciplines under blended learning conditions is a methodologically justified approach to ensuring continuity of the educational process and enhancing the development of students’ professional competencies. It has been demonstrated that the hybrid didactic model combining physical laboratory experiments with virtual simulation expands the functional capabilities of the learning experiment through parameter variability, experiment repeatability, and safe execution of laboratory work.

The experimental-methodological analysis of the thyristor study case confirms that simulation environments adequately reproduce the dynamic operating modes of semiconductor devices, including turn-on, latching, and forced turn-off processes, thereby contributing to the formation of a systemic level of electrical engineering knowledge. It has been established that the use of virtual simulators within blended learning structures improves the didactic controllability of the educational process, enables individualization of learning pace, and enhances instructional interactivity.

The economic feasibility of the proposed approach has been substantiated, as it reduces the need for expensive laboratory equipment while maintaining an appropriate level of practice-oriented training. At the same time, it has been determined that the effectiveness of simulation-based learning depends on the digital competence of teaching staff and the quality of methodological support for laboratory activities.

Future research directions include expanding the range of electrical engineering objects for simulation modeling and formalizing criteria for assessing the development of practical competencies in blended learning environments.

Acknowledgements. During the preparation of this manuscript, ChatGPT (OpenAI) was used as an artificial intelligence tool for language editing, translation, and stylistic improvement of the scientific text. The use of this tool was limited exclusively to linguistic refinement and did not influence the scientific content, methodology, results, or conclusions of the study. The author bears full responsibility for the accuracy, integrity, and scientific validity of all presented material, including data interpretation, modeling results, and final conclusions.

References

1. Berestovoi, I. O. (2025). Zastosuvannia tsyfrovykh tekhnolohii pid chas navchannia: suchasna paradyhma osvity [Application of digital technologies in education: modern educational paradigm]. In Innovatsiini pidkhody do rozvytku kompetentnisnykh yakostei fakhivtsiv v umovakh profesiinoho stanovlennia: materialy IX Mizhnarodnoi naukovo-praktychnoi konferentsii (pp. 260–263).

2. Postova, S. A., Mysuk, O. Yu., & Cherniak, Yu. H. (2026). Transformatsiia instrumentariiu profesiinoi osvity: poiednannia onlain-navchannia ta vysokotekhnolohichnykh symuliatsiinykh trenazheriv [Transformation of professional education tools: combining online learning and high-tech simulation trainers]. Pedahohichna Akademiia: Naukovi Zapysky, (26). https://doi.org/10.5281/zenodo.18636842

3. Oloniuk, O. A., Semenyshena, R. V., & Duhanets, V. I. (2024). Virtualni laboratorii yak instrument pidvyshchennia yakosti pidhotovky maibutnikh fakhivtsiv u sferi enerhetyky [Virtual laboratories as a tool for improving the quality of training future specialists in the energy sector]. Profesiino-prykladni dydaktyky, (2), 65–70. https://doi.org/10.37406/2521-6449/2024-2-11

4. Korshevniuk, T. V., & Berestovoi, I. O. (2026). Efektyvnist adaptyvnykh navchalnykh system na osnovi shtuchnoho intelektu u STEM-dystsyplinakh [Effectiveness of adaptive learning systems based on artificial intelligence in STEM disciplines]. Pedahohichna Akademiia: Naukovi Zapysky, (29). https://doi.org/10.5281/zenodo.20136408

5. Kudin, A. (2021). Orhanizatsiia samostiinoi roboty studentiv na bazi symuliatsiinoho laboratornoho praktykum z osnov tsyfrovoi elektroniky [Organization of students' independent work based on a simulation laboratory practicum in fundamentals of digital electronics]. Fizyko-matematychna osvita, 30(4), 61–67. https://doi.org/10.31110/2413-1571-2021-030-4-009

6. Mozghovyi, O., Vidmachenko, A., Subotina, V., & Palchyk, O. (2026). Zastosuvannia kompiuternykh prohram-symuliatoriv dlia modeliuvannia elektrychnykh skhem u navchalnomu protsesi [Use of computer simulation programs for modeling electrical circuits in the educational process]. Matematyka, informatyka, fizyka: nauka ta osvita, 2(2), 327–337. https://doi.org/10.31652/3041-1955-2025-02-02-16

7. Novikova, V. Ye., & Hlushko, O. M. (2025). Efektyvnist zastosuvannia suchasnykh onlain-symuliatoriv v protsesi formuvannia profesiinoi kompetentnosti fakhivtsiv kharchovykh i pererobnykh vyrobnytstv v umovakh dystantsiinoho navchannia [Effectiveness of modern online simulators in forming professional competence of specialists in food and processing industries under distance learning conditions]. Pedahohichna Akademiia: Naukovi Zapysky, (18). https://doi.org/10.5281/zenodo.15675346

8. Falstad, P. (n.d.). Circuit Simulator Applet. https://www.falstad.com/circuit/

STUDENT PERFORMANCE PREDICTION USING MACHINE LEARNING

Damir Syzdykov[1]
Selcuk Cankurt[2]
[1]*Department of Information Systems, SDU University, Kaskelen, Kazakhstan*
[2]*Department of Computer Science, SDU University, Kaskelen, Kazakhstan*
DOI: 10.5281/zenodo.20610090

Abstract
The problem of early prediction of at-risk students is an essential issue in contemporary education frameworks. In this research paper, we propose a comprehensive machine learning pipeline for predicting student academic performance on the OULAD dataset containing information about 32,593 learners enrolled in 22 different classes. In this work, we compare four models – XGBoost, LightGBM, Random Forest, and Logistic Regression – assess the influence of domain-oriented features engineering and Synthetic Minority Over-sampling Technique (SMOTE) data balance strategy, and employ Optuna for Bayesian hyperparameter optimization of the selected models. The XGBoost model with Optuna optimization, shows 97% test AUC and 91% test F1 score. An ablation experiment estimates the significance of each step of our pipeline, while SHapley Additive exPlanations (SHAP) values deliver interpretable results and explain individual predictions in the context understandable by educators.
Keywords: learning analytics, student performance prediction, educational data mining, feature engineering

I. Introduction

Student attrition and poor academic performance have continued to be recurring problems within higher education institutions across the world. Research conducted by Tinto [1] on student retention reveals that the process of student attrition is characterized by academic and social integration, hence the need to detect disengagement in its early stages. In addition to being an indicator of institutional poor performance, early academic failure brings about serious ramifications for the student. Intervention in advance before the student becomes beyond help can significantly increase student retention [2].

Virtual Learning Environments (VLEs) in online and hybrid courses have provided a unique chance for creating detailed time-stamped logs of user activities that act as early indicators. In combination with demographics and performance information, clickstream data allows for predictive models to identify students who may be at risk weeks before the end of a particular course. Such a model, referred to as learning analytics, has developed very quickly during the last ten years, partly due to benchmark datasets such as the OULAD dataset from the Open University [5].

Despite a large body of literature applying machine learning to student performance prediction, several gaps remain. First, many studies report only a single model, which makes it difficult to determine whether performance gains come from the modelling approach itself or from the particular dataset and evaluation design. This gap motivates the first two research questions, which ask which student features are most predictive and which learning algorithm best captures the structure of the data. Second, the contribution of feature engineering and class-imbalance correction is rarely quantified through ablation, so it remains unclear how much each pipeline component actually improves performance. This limitation leads directly to the third research question on the contribution of feature engineering, SMOTE, and hyperparameter tuning. Third, model interpretability, which is essential for educator adoption, is frequently omitted or reduced to global feature importance plots. This gap motivates the fourth research question, which focuses on whether SHAP-based explanations can generate insights that are useful for educators and policymakers.

Research Questions:

1) Which student demographic and behavioural features are most predictive of final academic outcome?
2) Which machine learning model best captures the complex, non-linear relationships in student data?
3) How much does each pipeline stage (feature engineering, SMOTE, hyperparameter tuning) contribute to predictive perfor- mance?
4) What actionable insights can SHAP-based model interpretation provide to educators and policymakers?

The remainder of this paper is organised as follows. Section II surveys related work. Section III describes the OULAD dataset and exploratory analysis. Section IV details the full machine learning pipeline. Section V presents experimental results. Section VI discusses findings and limitations, and Section VII concludes with future directions.

II. Related Work

Learning analytics and educational data mining have become two key research areas in the study of learner behavior and intervention strategies in higher education. General review articles laid out the groundwork of the area before specific modeling articles came along. The work of Romero and Ventura [7] provided a literature review of classifications, clusters, and association rules within an educational context, while Baker and Yacef [2] positioned educational data mining as a unique discipline. A series of subsequent literature reviews by Papamitsiou and Economides [3], on the one hand, and Avella et al. [4], on the other, demonstrated that predicting, profiling, and providing feedback had become popular applications.

Another set of related studies focuses on benchmark data sets, such as the Open University Learning Analytics Data Set (OULAD). Kuzilek et al. [5] presented OULAD as a massive, anonymised dataset encompassing demographic data, assessment results, and detailed interaction logs within the Virtual Learning Environment (VLE) of 32,593 learners from 22 module-presentations. This dataset has been made public to facilitate more reproducible model comparisons. Jin et al.'s [6] recent systematic review indicates that research using the OULAD dataset has primarily addressed final performance prediction, early warning detection, and engagement modelling.

The third class of researches applies classical machine learning and ensemble algorithms. Kotsiantis [8] proved at an early stage that machine learning would outperform traditional heuristics in terms of supporting decision making. As the trend continues, ensemble techniques are now gaining popularity and gradient boosting is particularly preferred. The algorithm XGBoost [10], and its variant LightGBM [11], are well-suited for educational tabular data due to their ability to model non-linear dependencies and cope with diverse features post-encoding.

Another line of research focuses on early warning systems. Macfadyen and Dawson [9] have demonstrated that data about the use of learning management system can serve as useful indicators for educators. The approach has been further improved upon by Adnan et al. [12] who conducted research on how effective prediction models become at various levels of course completion. In essence, all these studies underscore that the importance of any type of prediction model lies in its ability to detect at-risk students sufficiently early.

Another set of papers focuses on feature engineering, resampling, and model interpretability. Existing studies have demonstrated repeatedly that engagement metrics, examination behavior, and previous education are some of the most valuable features for predicting academic success [5], [16]. For resampling, SMOTE is still one of the most widely used methods; however, it should be done cautiously so that there is no data leakage between training and testing phases [18]. To explain the machine learning models, Lundberg and Lee [17] proposed the SHapley Additive exPlanations (SHAP), which has gained much popularity due to its ability to provide both global and individual student explanations.

Taken together, these method-oriented strands suggest that effective student performance prediction systems should combine benchmark learning-analytics data, strong ensemble models, purposeful feature engineering, careful imbalance handling, and inter pretable explanations. Table I summarises a small set of representative OULAD studies and highlights the methodological gaps that remain across the literature.

TABLE I

Representative OULAD studies and selected reported results. NR = not reported in the cited source.

Paper	Year	Model	AUC	F1	Key limitation
Adnan et al. [12]	2021	Random Forest	NR	0.79	Focuses on early checkpoints; no AUC and limited interpretability.
Shaikhanova et al. [13]	2025	Gradient Boosting	0.79	NR	Ultra-early setting prioritises workload, but performance is lower and feature engineering is not the main focus.
Lu et al. [15]	2025	Clustered LightGBM	0.86	0.78	Gains depend on course clustering and do not provide a unified full-dataset explainable pipeline.

None of these studies combined domain-driven feature engineering, SMOTE, Optuna tuning, and SHAP explanations in one reproducible pipeline on the full OULAD dataset.

III. Dataset and Exploratory Data Analysis

A. The OULAD Dataset

The Open University Learning Analytics Dataset (OULAD) [5] is a publicly available and anonymised learning analytics dataset collected from The Open University in the United Kingdom. It contains records for 32,593 students across 22 module-presentation pairs offered between 2013 and 2014. Because it combines demographic information, assessment outcomes, and detailed Virtual Learning Environment (VLE) interaction logs, OULAD has become a widely used benchmark for student performance prediction and early-warning research.

In this research study, the OULAD dataset will be utilized to design a binary classification problem, where the outcome would depend on the final performance of the student. In this classification, the original feature final_result will be re-coded into *Pass* and *Distinction* as belonging to the positive class and *Fail* and *Withdrawn* as belonging to the negative class. It is applicable in early-intervention cases since it captures both positive and negative results as well as the imbalance of classes present in the original data.

The classification of binary values is suitable for an early warning system because its main aim is to identify whether the students will pass or fail or withdraw from the course. Even though distinction and pass are two different grades, both of them are put under one category for better intervention planning.

B. Exploratory Data Analysis

Figure 1 shows the distribution of final results across the dataset. The four outcome categories are approximately: Pass (38%), Withdrawn (32%), Fail (15%), and Distinction (15%), producing an overall pass rate of approximately 53%.

The distributions of relevant numerical attributes split by target classes can be seen in Figure 2. Students who passed generally exhibited higher values compared to other groups in terms of total_clicks, active_days, and mean_score. This indicates that the VLE participation and test scores are strong predictors of the target variable.

The correlation between the categorical attributes and the target result is presented in Figure 3. It should be highlighted that there is a positive correlation between the pass rate and the educational qualification of the students (HE Qualification, Post Graduate). In addition, students belonging to the 55<= age range have comparatively lower pass rates.

IV. Methods

A. Data Preprocessing

Raw OULAD tables are concatenated into the flattened feature matrix through a series of left joins, wherein studentInfo is first joined with VLE statistics tables (sum clicks, active days, mean clicks per day) using the join key id_student, code_module, code_presentation; subsequently, with assessment statistics tables; and ultimately, with course tables.

Missing values are imputed using SimpleImputer where median is used for numeric variables and most frequent for categorical variables. Ordinal categorical features like highest_education and imd_band are coded based on their ordinality. The rest are label encoded and are modeled as categorical for tree-based models.

The data is split into three categories - training, validation, and testing. The ratio is 70:15:15, respectively. Stratified sampling is used for splitting the data. The random seed is set to be 42.

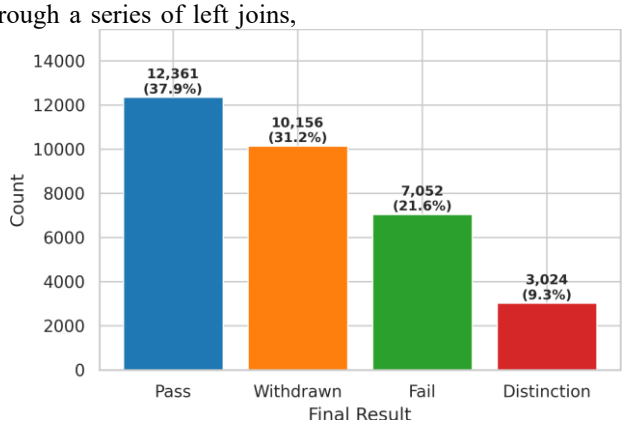


Fig. 1. Distribution of final academic outcomes across the OULAD dataset. Pass and Distinction constitute the positive class (53%); Fail and Withdrawn form the negative class (47%).

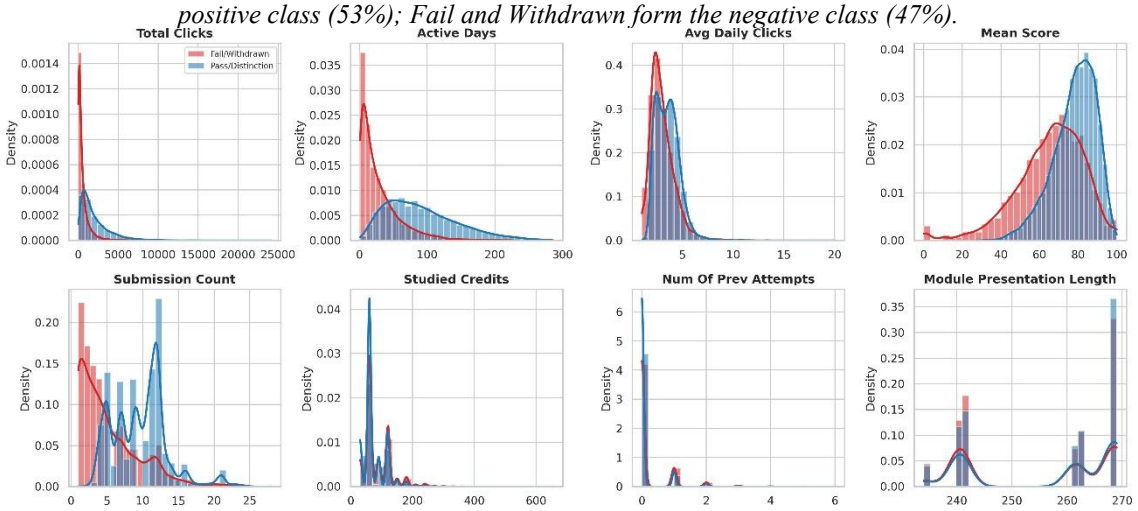


Fig. 2. Distributions of numerical features stratified by target class (Pass/Distinction vs. Fail/Withdrawn). KDE overlays facilitate comparison of distributional shape and separation.

B. Feature Engineering

Beyond the raw merged features, we derive four composite features motivated by educational theory:

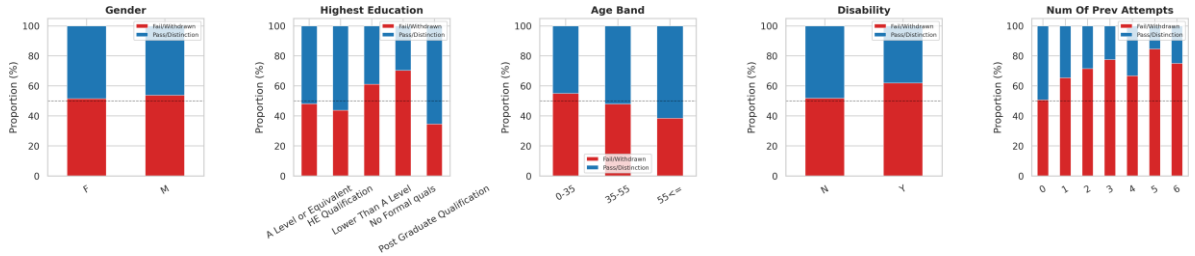


Fig. 3. Pass rates by categorical feature levels. Error bars indicate 95% confidence intervals from bootstrap sampling.

$$\text{clicks_per_credit} = \frac{\text{total_clicks}}{\text{studied credits} + 1} \quad (1)$$

$$\text{engagement ratio} = \frac{\text{active_days}}{\text{module presentation length} + 1} \quad (2)$$

$$\text{clicks per active day} = \frac{\text{total_clicks}}{\text{active days} + 1} \quad (3)$$

$$\text{score consistency} = \text{mean score} \times \log(\text{submission count} + 1) \quad (4)$$

The purpose of having the score consistency feature is to incorporate effort in a manner that is not possible through raw scores alone. When a student manages to achieve an impressive mean score after many submissions, it means he has persisted and remained engaged for some time, while a comparable mean score from just one or two submissions proves less about effort than a mean score based on several submissions. The inclusion of log of number of submissions makes sure that those who submit many papers don't overshadow the rest.

Furthermore, logarithmic transformations of the total_clicks and active_days columns are included to reduce right skew. The logarithmic transformation is utilized here due to the long right tail present in the engagement features, which includes few instances where students have very high click rates or many active days. Unlike other techniques such as clipping and min-max normalization, the logarithmic function allows for the compression of extreme outliers but maintains student ranking and moderate value differences. Two additional risk indicators are the risk_index and late_submission_ratio. A total of 25 potential features are included in the engineered feature set.

C. Feature Selection

Three complementary feature selection strategies are employed:

Filter methods. Mutual information scores and ANOVA F-statistics are computed between each feature and the binary target. Figure 4 visualises these scores, confirming that mean_score, active_days, and total_clicks are consistently top-ranked. Embedded method. A Random Forest classifier is trained on the full feature set, and permutation importance scores are extracted.

Figure 5 shows these scores, which largely corroborate the filter method rankings.

The final selected feature set of 12 features (listed in Table II) is determined by the intersection of top-ranked features across all three methods. This set is used as input to all subsequently trained models.

D. Class Imbalance Handling

The training set exhibits mild class imbalance (approximately 55% positive, 45% negative). We apply Synthetic Minority Over- sampling Technique (SMOTE) [18] with k=5 nearest neighbours exclusively to the training split, after feature selection, to prevent leakage of synthetic samples into the validation or test sets.

In order to guarantee fairness in assessment and prevent data leakage, all preprocessing tasks, such as feature selection and resampling, are only applied to the training dataset. The validation dataset will be kept aside for one final evaluation round.

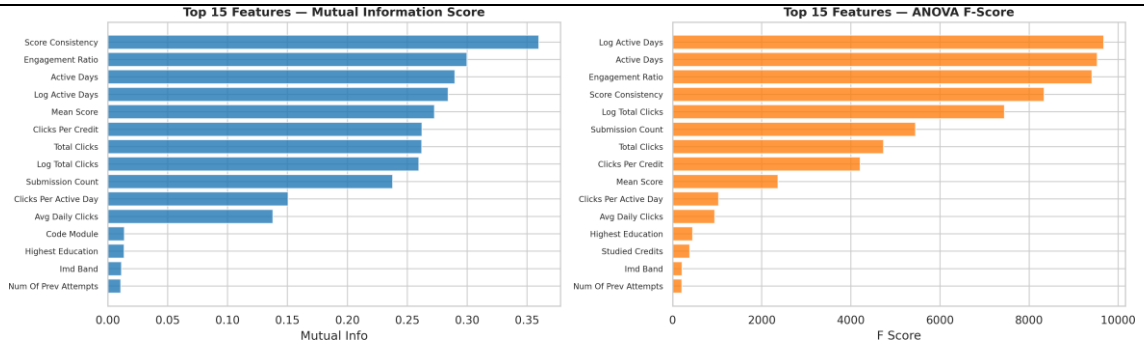


Fig. 4. Filter-method feature importance scores. Left: Mutual Information. Right: ANOVA F-statistic. Both methods agree on the dominance of VLE engagement and assessment features.

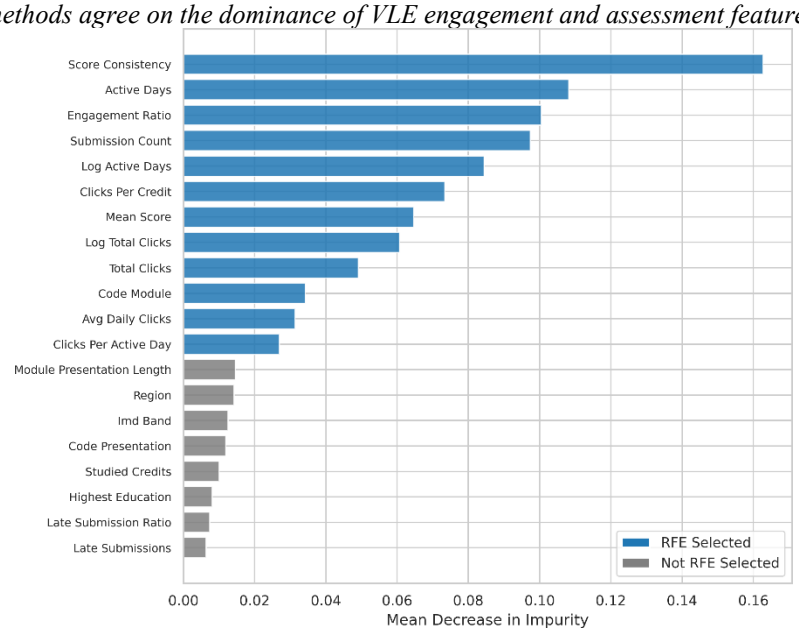


Fig. 5. Permutation-based feature importance from a Random Forest trained on the full engineered feature set.

E. Model Training and Evaluation

Four classifiers are trained and evaluated in this study: Logistic Regression as a regularised linear baseline, Random Forest as a bagged tree ensemble with 200 decision trees, XGBoost as a gradient-boosted tree model with learning rate 0.1 and maximum depth 6, and LightGBM as a histogram-based gradient-boosting method with leaf-wise tree growth. This combination enables comparison between linear, bagging-based, and boosting-based approaches on the same prediction task.

All models are evaluated on training, validation, and held-out test sets. In addition, five-fold stratified cross-validation (CV) F1 and AUC are reported on the training set to assess generalisation more reliably. To quantify overfitting, an *Overfit Gap* is defined as:

Table II

Selected feature set after engineering and selection.

Feature	Type	Description
active_days	Raw VLE	Days with at least one VLE interaction
total_clicks	Raw VLE	Total number of VLE resource clicks
mean_score	Assessment	Mean weighted assessment score
avg_daily_clicks	Raw VLE	Average clicks on active days
submission_count	Assessment	Number of assessments submitted
clicks_per_active_day	Engineered	Click intensity per active day
engagement_ratio	Engineered	Active days relative to course length
clicks_per_credit	Engineered	Clicks normalised by studied credits
log_total_clicks	Engineered	Log-transformed total clicks
score_consistency	Engineered	Score × log(submissions)
code_module	Categorical	Course module identifier
log_active_days	Engineered	Log-transformed active days

$$\Delta\text{overfit} = \text{F1train} - \text{F1CV} \quad (5)$$

Where there is a significant overfit gap ($\Delta_{overfit} > 0.05$), it shows memorization over generalization. The value of this measurement is that it makes a comparison between how well the model can fit the information it is exposed to, and how well it can perform when it comes to cross-validation – essentially, a simulation of unseen students. A low overfit gap indicates that strong training performance is likely to generalise to unseen data.

F. Hyperparameter Optimisation

Bayesian hyperparameter tuning for the XGBoost algorithm (100 trials) and the LightGBM algorithm (50 trials, fast mode) is performed via Optuna [19]. The optimisation criterion is maximisation of the 5-fold cross-validation Area Under the Curve on the training data. In case of the XGBoost algorithm, the tree depth parameter is chosen from the interval [3; 8] while learning rate and the number of estimators are tuned through the log-uniform intervals [0.01; 0.3] and [100; 500], respectively. Moreover, the subsample and colsample_bytree parameters associated with sampling techniques are optimised in the interval [0.6; 1.0]. Also, the two regularisation parameters reg_alpha and reg_lambda are tuned within the log-uniform range $[10^{-8}; 10]$.

G. SHAP Interpretability

SHapley Additive exPlanations (SHAP) [17] are computed for the best-performing model (XGBoost Optuna) using shap.TreeExplainer with exact computation. Both global (beeswarm, bar chart) and local (waterfall) explanations are produced.

V. Results

A. Model Comparison

Metrics of all six models are provided in Table III. XGBoost with Optuna optimization performs better in terms of both Test AUC (0.9698) and Test F1 (0.9041) than all other models, while having the smallest overfitting rate compared to other gradient boosting algorithms ($\Delta_{overfit}$ = 0.0178). Logistic regression, despite its quick training time (0.10 s), underperforms other models in all categories, thus verifying the non-linear character of the problem.

Figure 6 provides a visual comparison of test-set F1, AUC, accuracy, precision, and recall across all models. Gradient-boosted models cluster tightly at the top of performance, while Logistic Regression is clearly separated.

Table III

Model performance comparison across training, validation, and test sets. CV metrics are computed on 5-fold stratified cross-validation. Overfit Gap = Train F1 − CV F1.

Model	Train (s)	Train		Validation		Test		CV		Overfit Gap
		F1	AUC	F1	AUC	F1	AUC	F1	AUC	
XGBoost (Optuna)	0.82	0.931	0.981	0.9044	**0.9660**	**0.9041**	**0.9698**	**0.9106**	**0.9681**	0.0178
XGBoost	3.14	0.9617	0.9945	0.9041	0.9655	0.9021	0.9693	0.9097	0.9678	0.0474
LightGBM (Fast Optuna)	0.47	0.9417	0.9871	**0.9046**	0.9654	0.9031	0.9691	**0.9106**	0.9679	0.0277
LightGBM	5.25	**0.9816**	**0.9991**	0.9034	0.9642	0.9020	0.9689	0.9105	0.9668	0.0655
Random Forest	16.87	0.9399	0.9867	0.8974	0.9614	0.8982	0.9657	0.9033	0.9631	0.0336
Logistic Regression	**0.10**	0.8168	0.9091	0.8122	0.9109	0.8114	0.9136	0.8147	0.9094	**−0.0001**

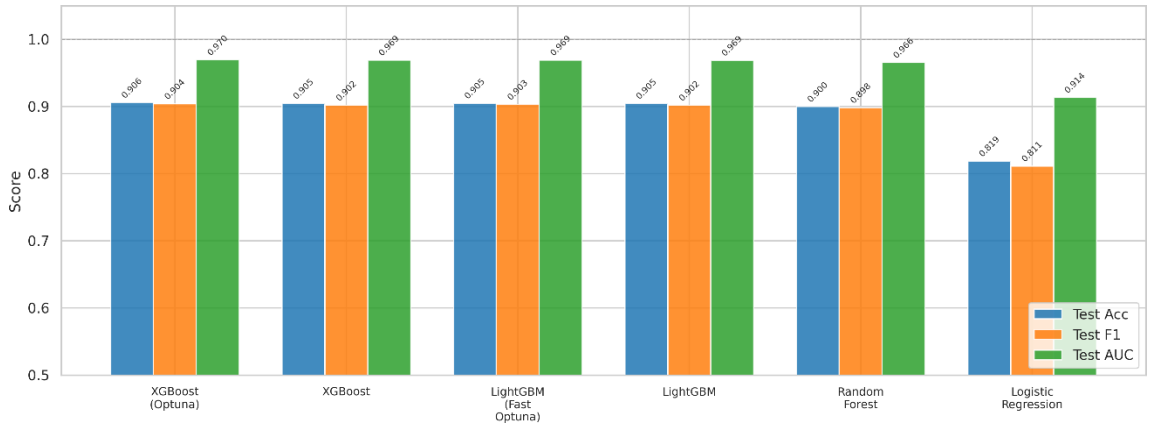


Fig. 6. Radar / bar comparison of test-set performance metrics for all six model configurations. XGBoost (Optuna) achieves the best overall balance of F1 and AUC.

B. ROC Curves and Confusion Matrices

Figure 7 depicts ROC curves of all models on the test dataset. The AUC of gradient boosted models falls in the range of 0.966 to 0.970, implying high discriminative capabilities. The logistic regression model attains AUC of 0.914, indicating the limitations of its linear classifier in non-linear space.

From the analysis of the classification results of the testing set, it can be observed that the highest level of performance can be seen from the XGBoost (Optuna), whereas logistic regression is noted for having a high level of false negatives by misclassifying the students at risk as those who will pass.

C. Overfitting Analysis

Figure 8 plots training versus cross-validation F1 scores for all models. LightGBM (default) shows the largest overfit gap ($\Delta = 0.0655$), caused by its leaf-wise tree growth without tuning. XGBoost (Optuna) achieves the best generalisation among gradient-boosted models, while Logistic Regression shows virtually no overfitting ($\Delta \approx 0$).

D. Ablation Study

An ablation analysis was conducted to examine the contribution of each pipeline stage for the XGBoost (Optuna) model. The baseline model trained on raw features achieved F1 = 0.9076 and AUC = 0.9696. Adding feature engineering slightly reduced AUC

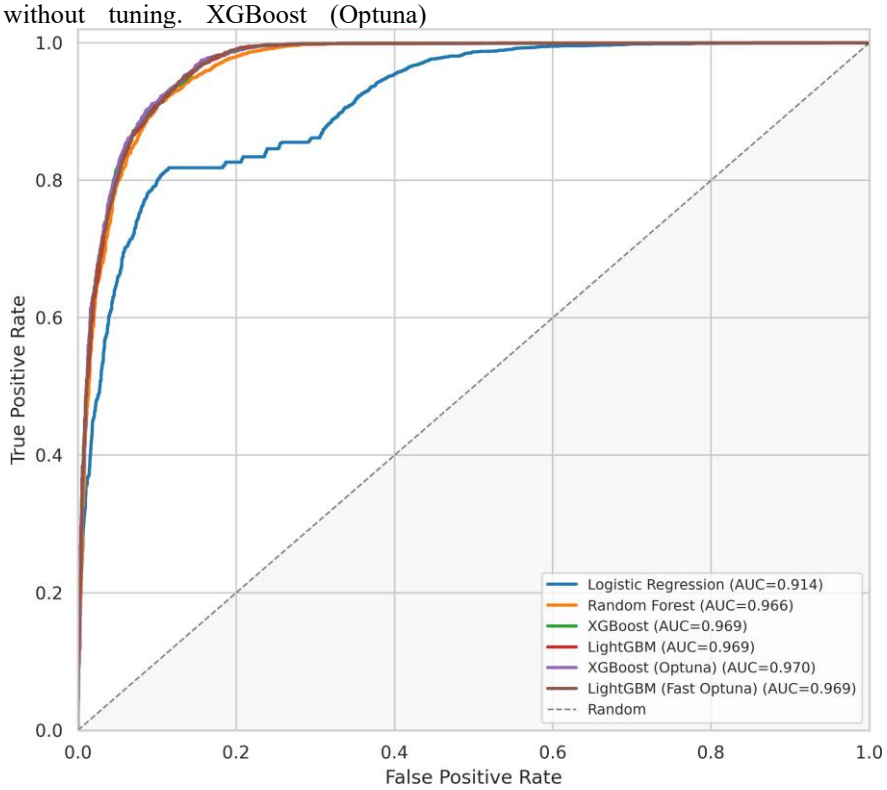


Fig. 7. Receiver Operating Characteristic (ROC) curves for all models on the held-out test set. Shaded regions denote the area under the curve (AUC).

in this configuration, likely because the selected feature subset changed, while the inclusion of SMOTE and Optuna tuning raised the final AUC to 0.9698. Overall, the analysis suggests that the combined pipeline provides a strong balance of predictive performance and generalisation, although improvements from individual components are relatively modest.

E. SHAP Interpretability

The overall importance, depicted in Figure 9, is derived from the average SHAP values calculated using the test set. As per the findings, the two highest-ranked features in terms of significance include score_consistency (which is a new feature created through engineering) and active_days. After these come the features named submission_count and code_module. It is evident from the analysis that continuous engagement and consistent performance are the key determinants of success for students. Specifically speaking, in terms of education, the model takes into account both the frequency of participation and consistency in performance by students.

As seen in Fig. 10, the beeswarm chart of SHAP values offers an even finer-grained look at the impact of features. Every dot corre- sponds to one particular student, where red/blue colouring denotes the feature level (high/low), while the position of each dot denotes the influence of a certain feature value on the prediction score (direction). Features with high levels of score_consistency and active_days will be associated with positive outcomes, while low levels lead to negative ones.

Lastly, Figure 11 shows a waterfall plot of SHAP values for a typical at-risk student, providing an in-depth interpretation of a single instance's prediction. The starting point is the average prediction, $E[f(X)] \approx 0.53$. From there, the prediction is modified according to the contributions of all features. Here, a larger number of active_days has a positive influence, whereas low

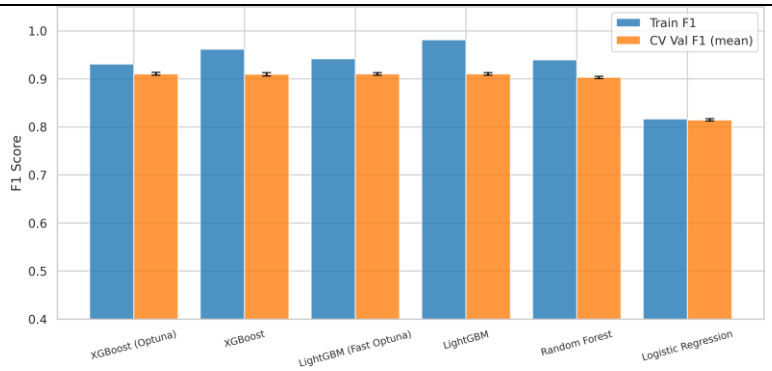


Fig. 8. Training F1 vs. cross-validation F1 for all models. Points above the diagonal dashed line (Train F1 = CV F1) indicate overfitting.

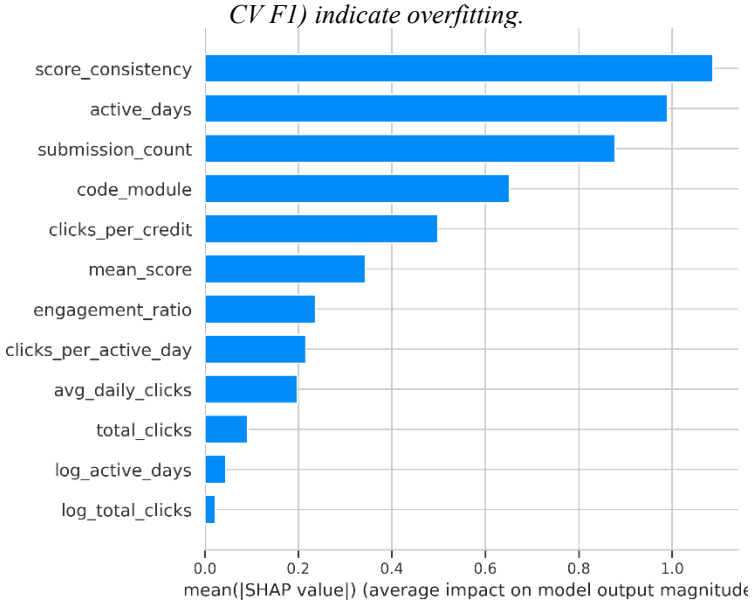


Fig. 9. Global SHAP feature importance (mean |SHAP| over the test set). Higher values indicate greater average impact on model output. For a teacher, this chart shows which student characteristics most strongly influence the model's decisions across the whole class.

score_consistency and low submission_count have very negative impacts, leading to a final prediction that falls below the decision boundary. This kind of detailed analysis is especially helpful for teachers in understanding the reasons behind the student's classification.

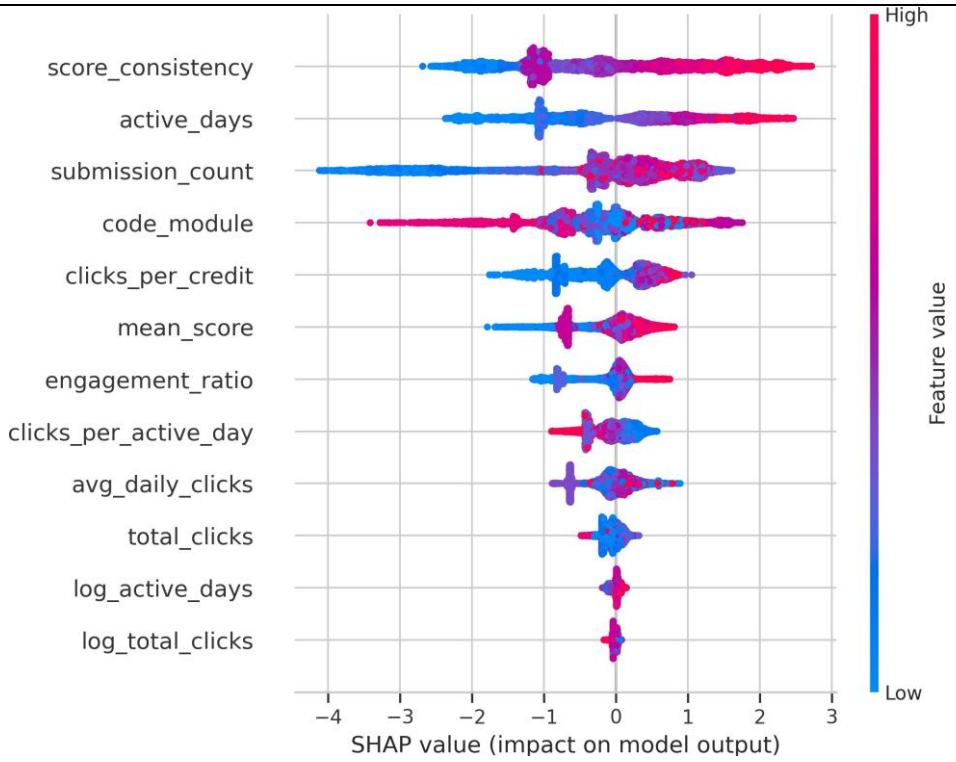


Fig. 10. SHAP beeswarm plot for the XGBoost (Optuna) model. Each point represents one test-set student. Colour indicates feature value (red = high, blue = low). For a teacher, this chart shows whether high or low values of each feature tend to push an individual student toward a pass or at-risk prediction.

VI. Discussion

A. Key Findings

According to the results, engagement-related factors emerge as the best predictors of any selected feature set, namely using mutual information, ANOVA F-statistics, permutation importance, or SHAP. For instance, the number of active study days, clicks, and the generated engagement factor are always among the top-ranking predictors. This finding is consistent with previous studies [12], [16], where it was noted that digital behavioral footprints are indicative of intention to learn and self-regulatory behaviors.

The second crucial insight relates to the significance of score consistency, which is an aggregate variable. Score consistency, defined as mean score multiplied by the log of submission count, has the highest SHAP value and outperforms both mean score and submission count when considered individually. The implication of this result is that consistent participation in testing has value in itself.

When it comes to choosing a suitable model, the Optuna-tuned XGBoost is the optimal one when it comes to generalization since it has an overfit difference of 0.018 compared to other gradient boosted models. It is also considerably faster in terms of training time compared to untuned LightGBM (0.82 seconds versus 5.25 seconds).

Logistic Regression reaches an AUC of 0.914 and an F1 score of 0.811, which confirms that the underlying prediction task is strongly non-linear. At the same time, its zero overfit gap and short training time make it a useful interpretable baseline and a potentially valuable component in ensemble settings.

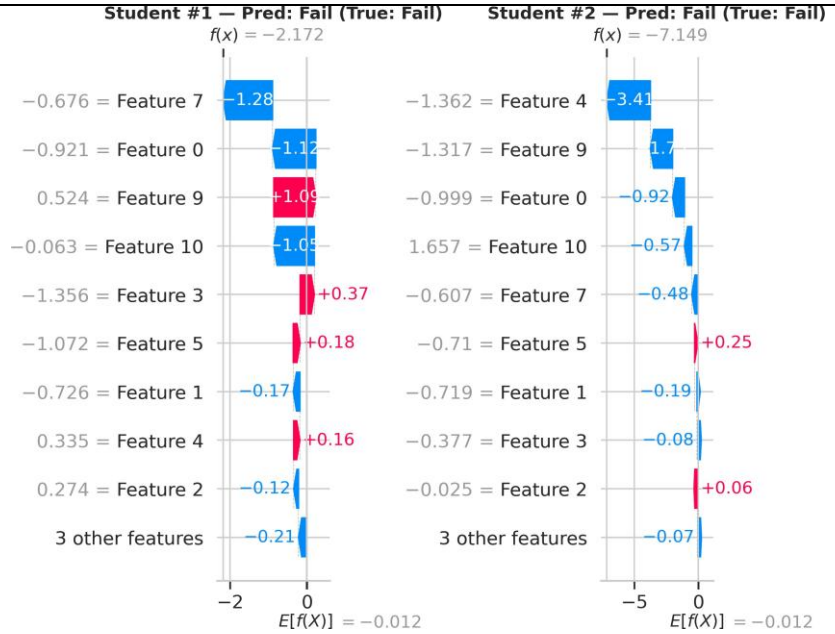


Fig. 11. SHAP waterfall plot for an individual at-risk student. Red bars push towards prediction of failure; blue bars push towards prediction of success. The final output probability is shown at the top.

The SHAP findings also have practical implications for educators and institutional decision-makers. In particular, low early VLE engagement, repeated prior attempts, late submission behaviour, socioeconomic disadvantage, and weak formative assessment participation all highlight potential areas for intervention, such as tutor outreach, academic counselling, reminder systems, targeted support programmes, and more frequent low-stakes assessment.

B. Limitations

Some of the shortcomings are worth noting. For instance, despite the fact that the current research applies OULAD data as is, the dataset consists of information from only one institution and time frame of data collection, which poses certain constraints regarding the generalizability of the results obtained to other universities or other ways of organizing courses and studying. Another drawback is the dichotomization of participants into those who either withdraw or fail. In addition, time-series analysis of interactions on VLE could reveal the dynamics of student performance better than a simple aggregation of data. Finally, no causal inference has been conducted.

VII. Conclusion

In this paper, a machine learning pipeline was designed that is comprehensive and reproducible for prediction of student academic performance based on OULAD dataset. The pipeline includes data integration and pre-processing, domain-driven features creation, feature selection by different methods, SMOTE for class balancing, hyperparameter optimisation by Bayesian technique and explainability by SHAP technique. XGBoost model using Optuna achieves the best performance among the evaluated models on the test data (AUC = 0.9698, F1 = 0.9041) and exhibits minimal gap between train and test performance.

The next steps in research need to be aimed at enhancing the practicality of such models in real-life settings. For example, predicting Pass, Distinction, Fail and Withdrawal statuses for multiple classes could assist in delivering different types of intervention for various kinds of students rather than viewing them as one big group requiring the same attention. Additionally, using temporal modelling to predict weekly online activity could enable institutions to identify students requiring support at earlier stages during the academic year, meaning that interventions would be more effective due to being delivered on time. In addition, analyzing the fairness of such predictive models is required to prevent discrimination against specific demographic categories once those models are put into action.

References

1. V. Tinto, “Dropout from higher education: A theoretical synthesis of recent research,” *Review of Educational Research*, vol. 45, no. 1, pp. 89–125, 1975.

2. R. S. J. d. Baker and K. Yacef, “The state of educational data mining in 2009: A review and future visions,” *Journal of Educational Data Mining*, vol. 1, no. 1, pp. 3–17, 2010.

3. Z. Papamitsiou and A. A. Economides, “Learning analytics and educational data mining in practice: A systematic literature review of empirical evidence,” *Educational Technology & Society*, vol. 17, no. 4, pp. 49–64, 2014.

4. J. T. Avella, M. Kebritchi, S. G. Nunn, and T. Kanai, “Learning analytics methods, benefits, and challenges in higher education: A systematic literature review,” *Online Learning*, vol. 20, no. 2, pp. 13–29, 2016.

5. J. Kuzilek, M. Hlosta, and Z. Zdrahal, “Open University Learning Analytics Dataset,” *Scientific Data*, vol. 4, no. 1, pp. 1–8, 2017.

6. L. Jin, L. Lingxi, *et al.*, “Predictive modelling

with the Open University Learning Analytics dataset (OULAD): A systematic literature review," in *Proceedings of the International Conference on Artificial Intelligence in Education*, Cham: Springer Nature Switzerland, 2024.

7. C. Romero and S. Ventura, "Educational data mining: A review of the state of the art," *IEEE Transactions on Systems, Man, and Cybernetics, Part C*, vol. 40, no. 6, pp. 601–618, 2010.

8. S. B. Kotsiantis, "Use of machine learning techniques for educational purposes: A decision support system for forecasting students' grades," *Artificial Intelligence Review*, vol. 37, no. 4, pp. 331–344, 2012.

9. L. P. Macfadyen and S. Dawson, "Mining LMS data to develop an 'early warning system' for educators: A proof of concept,"

Computers & Education, vol. 54, no. 2, pp. 588–599, 2010.

10. T. Chen and C. Guestrin, "XGBoost: A scalable tree boosting system," in *Proc. 22nd ACM SIGKDD Int. Conf. Knowledge Discovery and Data Mining*, pp. 785–794, 2016.

11. G. Ke et al., "LightGBM: A highly efficient gradient boosting decision tree," in *Advances in Neural Information Processing Systems*, vol. 30, 2017.

12. M. Adnan, A. Habib, J. Ashraf, S. Mussadiq, A. A. Raza, M. Abid, M. Bashir, and S. U. Khan, "Predicting at-risk students at different percentages of course length for early intervention using machine learning models," *IEEE Access*, vol. 9, pp. 7519– 7539, 2021.

13. A. Shaikhanova, O. Kuznetsov, K. Iklassova, A. Tokkuliyeva, and L. Sugurova, "Interpretable predictive modeling for educational equity: A workload-aware decision support system for early identification of at-risk students," *Big Data and Cognitive Computing*, vol. 9, no. 11, art. 297, 2025.

14. S. V. S. Gunasekara and M. Saarela, "Trade-offs between fairness and performance in educational AI: Analyzing post-processing bias mitigation on the OULAD," *Information and Software Technology*, vol. 189, art. 107933, 2025.

15. Y. Lu, S. Yeom, R. Ryu, and S.-H. Kim, "Course-level clustering to enhance dropout prediction accuracy," *IEEE Access*, vol. 13, pp. 204996–205013, 2025.

16. D. T. Tempelaar, B. Rienties, and B. Giesbers, "In search for the most informative data for feedback generation: Learning analytics in a data-rich context," *Computers in Human Behavior*, vol. 47, pp. 157–167, 2015.

17. S. M. Lundberg and S.-I. Lee, "A unified approach to interpreting model predictions," in *Advances in Neural Information Processing Systems*, vol. 30, pp. 4765–4774, 2017.

18. N. V. Chawla, K. W. Bowyer, L. O. Hall, and W. P. Kegelmeyer, "SMOTE: Synthetic minority over-sampling technique,"

Journal of Artificial Intelligence Research, vol. 16, pp. 321–357, 2002.

19. T. Akiba, S. Sano, T. Yanase, T. Ohta, and M. Koyama, "Optuna: A next-generation hyperparameter optimization framework," in *Proc. 25th ACM SIGKDD Int. Conf. Knowledge Discovery and Data Mining*, pp. 2623–2631, 2019.

20. J. Pearl, *Causality: Models, Reasoning and Inference*, 2nd ed. Cambridge University Press, 2009.

VETERINARY SCIENCES

STATE OF INTESTINAL MICROBIOCENOSIS AND BIOCHEMICAL BLOOD PARAMETERS OF CHICKENS UNDER FEEDING WITH FEED CONTAMINATED BY BIOTIC FACTORS AND THE USE OF CAMBRIAN CLAY

Mykola Bogach
doctor of veterinary sciences, professor
ORCID: 0000-0002-2763-3663
Nadiia Selishcheva
senior research fellow
ORCID: 0000-0002-1674-5811
Denys Bohach
PhD in Veterinary Medicine
ORCID: 0000-0002-1809-4338
Odessa Research Station of the National Scientific Center "Institute of Experimental and Clinical Veterinary Medicine", 2, Svobody Ave, Odessa, 65037, Ukraine
Olena Kolchyk
candidate of veterinary sciences, senior research fellow
ORCID: 0000-0003-0497-2512
National Scientific Center «Institute of Experimental and Clinical Veterinary Medicine», 83, Grigory Skovorody St., Kharkiv, 61023, Ukraine
Olena Bohach
PhD in Veterinary Medicine
Institute of Animal Biology of the National Academy of Sciences, 38 Vasyl Stus St., Lviv, 79034, Ukraine
ORCID: 0000-0001-5487-7033
DOI: 10.5281/zenodo.20610161

Abstract
The effect of Cambrian clay on productive performance, intestinal microbiocenosis, and biochemical blood parameters of chickens under feeding with low-toxic feed was investigated. It was established that feeding low-toxic feed resulted in a 23.2% decrease in body weight, a 3.06-fold reduction in average daily gain, and a 1.59-fold deterioration in feed conversion. Chickens developed intestinal dysbiosis accompanied by an increase in opportunistic microorganisms and suppression of Lactobacillus and Bifidobacterium. Biochemical alterations were characterized by a 12.9% decrease in total protein and a 22.2% decrease in globulins, as well as a 57.8% increase in cholesterol concentration and a 60.0% increase in ALT activity. The use of Cambrian clay improved productive performance, partially normalized intestinal microbiocenosis, and stabilized the biochemical status of chickens, indicating the prospects of its use as a natural enterosorbent in poultry farming.

Keywords: *Bifidobacterium*, *Candida albicans, Clostridium*, dysbiosis, *Enterosorbents,* microbiota, mycotoxins, chickens, toxic feed.

Introduction

One of the most pressing problems in modern poultry farming remains the contamination of grain raw materials by biotic factors, particularly microscopic fungi and their secondary metabolites — mycotoxins. According to recent meta-analyses, more than 70% of grain feed samples simultaneously contain several types of mycotoxins, the combined effects of which lead to intestinal dysbiosis, disruption of epithelial barrier integrity, and severe metabolic disorders in poultry [1, 2].

Mycotoxins are toxic metabolites produced by microscopic mold fungi that contaminate grain crops both during vegetation and storage and processing of feed. The main producers of mycotoxins dangerous for poultry farming are fungi of the genera Aspergillus, Fusarium, and Penicillium [3]. Consumption of contaminated feed negatively affects metabolism, immune status, and productivity of poultry, causing liver and kidney damage, reproductive disorders, and, in some cases, mortality [4].

Particular attention should be paid to the effect of mycotoxins on the functional state of the digestive tract and intestinal microbiome. Toxicants directly damage the intestinal mucosa, disrupt nutrient absorption, and alter the composition of intestinal microbiocenosis [5-7].

The normal intestinal microflora of poultry is represented by a complex association of facultative and obligate anaerobic microorganisms, among which lactobacilli, bifidobacteria, bacteroides, and other representatives of commensal microbiota play an important role [8]. Disturbance of the dynamic balance of intestinal microbiocenosis is accompanied by the development of dysbiosis, gastroenteritis, and enteritis, resulting in impaired feed conversion, decreased body weight gain, and reduced poultry productivity [9]. Changes in

the qualitative and quantitative composition of intestinal microflora are considered one of the key pathogenetic mechanisms in the development of intoxication and metabolic disorders in poultry [10-12].

In this regard, the search for effective means of feed detoxification and reduction of the negative impact of mycotoxins on poultry is highly relevant. Modern approaches are increasingly focused on the use of environmentally safe enterosorbents and natural adsorbents capable of binding toxic compounds in the digestive tract and reducing manifestations of oxidative stress [13-15].

A promising direction in poultry farming is the use of natural mineral enterosorbents, particularly zeolites and aluminosilicates, characterized by high adsorption and ion-exchange capacity and capable of effectively binding toxic compounds in the poultry digestive tract without significantly disturbing the balance of vitamins and trace elements [16, 17].

Along with traditional zeolites and bentonites, Cambrian blue clay attracts considerable interest as a natural aluminosilicate mineral rich in silicon, magnesium, iron, and other trace elements. Due to pronounced adsorption and ion-exchange properties, such minerals are able to bind toxic compounds and metabolic products, reducing the toxic load on the poultry organism. In addition, their use may positively affect mineral metabolism, digestion processes, and contribute to stabilization of intestinal microbiocenosis [18, 19].

However, the influence of Cambrian clay specifically on the dynamics of intestinal microbiocenosis and metabolic status of chickens under consumption of feed contaminated by biotic factors requires further investigation.

The aim of the study was to investigate the state of intestinal microbiocenosis and the characteristics of biochemical blood parameters in chickens fed feed contaminated by biotic factors and to evaluate the effectiveness of Cambrian clay as a corrective agent.

Materials and methods

The studies were conducted at the Laboratory of Epizootology, Parasitology, Monitoring of Animal Diseases and Providing of the Odesa Research Station of the National Scientific Center “Institute of Experimental and Clinical Veterinary Medicine” (NSC “IECVM”), as well as at the Laboratory of Clinical Biochemistry and the Laboratory for the Study of Swine Diseases of the NSC “IECVM”.

The experiment lasted 35 days and was carried out on 45-day-old Redbro chickens (n = 10). Three groups of poultry were formed according to the analogue principle. Chickens of Group I (control) received standard complete feed (SCF). The diet of Group II (experimental) consisted of 85% high-quality SCF and 15% low-toxic feed (LTF). Chickens of Group III (experimental) received 85% high-quality SCF, 15% LTF, and an additional 1% Cambrian clay.

Feed toxicity was determined according to DSTU 3570-97 (1999) using a bioassay on the test organism *Colpoda steinii*. Mycological studies revealed contamination of feed with micromycetes of the genera Aspergillus and Fusarium [20].

To evaluate intestinal microbiocenosis and determine the degree of dysbiosis, classical microbiological methods were used. Fresh poultry feces served as the material for investigation. The quantitative composition of the main representatives of obligate and opportunistic microflora, including *Lactobacillus* spp., *Bifidobacterium* spp., *Enterococcus* spp., *Escherichia coli*, *Clostridium* spp., and other opportunistic microorganisms, was determined in the collected samples. The degree of dysbiosis was assessed by a decrease in lactobacilli and bifidobacteria, an increase in opportunistic microflora, and disturbance of the ratio between obligate and facultative microbiota [6, 7].

To evaluate the functional state of chickens, biochemical blood serum parameters characterizing protein, enzymatic, and metabolic homeostasis were studied. Blood samples were collected from the wing vein in the morning before feeding. Blood was collected into dry tubes and kept at room temperature until clot formation, followed by centrifugation at 3000 rpm for 10 minutes. Blood serum was used for further biochemical analyses.

Biochemical parameters were determined using standard methods with reagent kits produced by “Filisit-Diagnostics” (Ukraine) on a Stat Fax 1904 Plus biochemical analyzer (USA). The following indicators were determined in blood serum: total protein by the biuret method; albumins using bromocresol green reaction; globulins by calculation method (difference between total protein and albumins); ALT and AST activity by the Reitman–Frankel method [21]; uric acid by enzymatic method; circulating immune complexes by the Khavkina method; seroglycoids by the orcinol reaction according to the Orlov method.

Clinical and productive indicators were additionally recorded, including feces consistency, frequency of diarrhea manifestations, feed conversion, body weight gain, and survival rate.

Mathematical analysis of the obtained data was performed using Microsoft Excel software (Microsoft Corporation, Redmond, Washington, USA) by calculating the arithmetic mean (M), standard error (m), and significance level (p) using one-way ANOVA with Fisher’s criterion [22].

Research results. According to clinical and productive indicators, feeding 45-day-old chickens with a diet containing 15% low-toxic feed for 35 days negatively affected poultry productivity (Table 1).

Table 1.

Effect of low-toxic feed and Cambrian clay on productive performance of chickens (M±m, n = 10)

Parameters	Group I, control	Group II, experimental	Group III, experimental
Initial body weight, g	7340 ± 0.13	7340 ± 0.11	7340 ± 0.12
Final body weight, g	11200 ± 0.18	8600 ± 0.09	10950 ± 0.14
Average daily gain at the end of the experiment, g	110.28	36.00	103.14
Average daily feed intake, g	240	320	250
Feed conversion ratio	3.2	5.1	3.4

At the end of the experiment, body weight in chickens of Group II was 23.21% lower compared with the control, while average daily gain decreased 3.06-fold. At the same time, average daily feed intake increased by 33.3%, and feed conversion worsened 1.59-fold, indicating reduced efficiency of nutrient utilization under toxic load.

Supplementation of the diet with Cambrian clay (Group III) improved productive performance of chickens. At the end of the experiment, body weight in this group was only 2.23% lower than in the control, while average daily gain differed by only 6.92%. Feed conversion ratio in Group III was 1.5 times lower compared with Group II and approached the values of healthy poultry. The obtained results indicate the ability of Cambrian clay to partially neutralize the negative effects of low-toxic feed on growth intensity and feed utilization efficiency.

Thus, feeding low-toxic feed caused pronounced growth suppression in chickens, reduced average daily gains, and worsened feed conversion. Inclusion of Cambrian clay into the diet significantly reduced the negative impact of toxic feed, which manifested as improved growth intensity and feed utilization efficiency.

During evaluation of intestinal microbiocenosis in chickens of Group I, it was established that the qualitative and quantitative composition of microflora corresponded to indicators characteristic of healthy poultry (Table 2).

Table 2.

Effect of low-toxic feed and Cambrian clay on microbiota of the large intestine in chickens (CFU/g)

Microorganisms	Group I, control	Group II, experimental	Group III, experimental
E. coli	35×10^8	48×10^8	38×10^8
Proteus	28×10^8	42×10^8	31×10^8
Enterococcus	13×10^8	16×10^8	14×10^8
Clostridium	17×10^8	41×10^8	30×10^8
Staphylococcus	22×10^8	39×10^8	33×10^8
Bacillus cereus	3×10^5	36×10^6	28×10^6
Candida albicans	2×10^3	14×10^5	9×10^5
Lactobacillus	4×10^5	–	–
Bifidobacterium	8×10^5	–	–

Feeding low-toxic feed caused pronounced disturbances in microbiocenosis of the large intestine in chickens. In poultry of Group II, the amount of *E. coli* increased 1.37-fold, *Proteus* – 1.5-fold, *Clostridium* – 2.41-fold, and *Staphylococcus* – 1.77-fold compared with the control group. The most pronounced changes were observed for *Bacillus cereus* and *Candida albicans*, whose counts increased 120- and 700-fold, respectively.

At the same time, chickens of Group II showed complete suppression of obligate intestinal microflora – *Lactobacillus* and *Bifidobacterium* were absent in the examined samples, indicating the development of severe dysbiosis under toxic load.

Supplementation of the diet with Cambrian clay (Group III) contributed to partial normalization of intestinal microbiota. Compared with Group II, the amount of *E. coli* decreased 1.26-fold, *Proteus* – 1.35-fold, *Clostridium* – 1.37-fold, *Staphylococcus* – 1.18-fold, *Bacillus cereus* – 1.29-fold, and *Candida albicans* – 1.56-fold. The obtained results indicate the ability of Cambrian clay to reduce the level of opportunistic microflora and partially stabilize intestinal microbiocenosis in chickens.

The next stage of the study involved investigation of biochemical blood serum parameters in chickens to evaluate the state of protein, enzymatic, and metabolic homeostasis under different feeding conditions (Table 3).

Table 3.

Biochemical blood serum parameters of chickens under feeding with low-toxic feed and Cambrian clay supplementation (M±m, n = 5)

Parameters	Group I, control	Group II, experimental	Group III, experimental
Total protein, g/L	46.80±0.98	40.76±1.02***	44.58±1.16***
Albumins, g/L	19.28±1.32	19.34±0.06***	19.68±0.34***
Globulins, g/L	27.52±1.14	21.42±0.76***	24.90±1.34***
A/G ratio	0.70±0.04	0.90±0.02	0.79±0.02
ALT, mmol/L·h	0.50±0.006	0.80±0.007**	0.62±0.02*
AST, mmol/L·h	2.52±0.004	2.10±0.002***	2.22±0.02***
Uric acid, mmol/L	0.282±0.05	0.326±0.03***	0.318±0.03***
Creatinine, μmol/L	26.44±0.48	30.19±0.36	29.45±0.05
Triglycerides, μmol/L	1.29±0.02***	1.49±0.07***	1.28±0.06***
Cholesterol, μmol/L	1.47±0.08***	2.32±0.04***	1.67±0.02***
Total calcium, μmol/L	2.25±0.008***	2.66±0.004***	2.28±0.07***
Inorganic phosphorus, μmol/L	1.48±0.02***	1.29±0.003***	1.33±0.004***

*Note: * $p<0.05$; ** $p<0.01$; *** $p<0.001$ compared with the control group.

Feeding chickens with low-toxic feed was accompanied by pronounced changes in biochemical blood serum parameters, indicating disturbances in protein, lipid, and mineral metabolism.

Compared with the control, chickens of Group II showed a 12.9% decrease in total protein concentration and a 22.2% decrease in globulin levels, indicating suppression of protein-synthesizing function and decreased immunological reactivity. Simultaneously, the A/G ratio increased by 28.6%, indicating the development of dysproteinemia.

Metabolic disturbances were characterized by increased concentrations of uric acid by 15.6%, creatinine by 14.2%, triglycerides by 15.5%, and cholesterol by 57.8% compared with the control group. ALT activity in Group II chickens increased by 60.0%, whereas AST activity decreased by 16.7%. In addition, total calcium concentration increased by 18.2%, while inorganic phosphorus decreased by 12.8%.

In chickens of Group III supplemented with Cambrian clay, most biochemical parameters were closer to control values. Total protein concentration was only 4.7% lower than in the control, while globulins were 9.5% lower. The A/G ratio exceeded control values by 12.9%. Cholesterol levels were 13.6% higher than in the control, triglycerides practically did not differ from the control, while uric acid concentration exceeded control values by 12.8%. ALT activity was 24.0% higher than in the control, whereas AST activity remained 11.9% lower. At the same time, total calcium concentration exceeded control values by only 1.3%, and inorganic phosphorus remained 10.1% lower.

Compared with Group II, supplementation with Cambrian clay promoted partial normalization of protein, lipid, and mineral metabolism, which was manifested by increased concentrations of total protein and globulins and decreased cholesterol, triglycerides, and ALT activity.

The obtained results indicate the ability of Cambrian clay to reduce the severity of metabolic disorders caused by feeding low-toxic feed.

Conclusions

1. Feeding chickens with a diet containing 15% low-toxic feed for 35 days caused a decrease in body weight, average daily gain, and feed conversion efficiency, and was accompanied by the development of intestinal dysbiosis characterized by an increase in opportunistic microflora and suppression of obligate microorganisms (Lactobacillus, Bifidobacterium).

2. Toxic feed load was accompanied by disturbances in protein, lipid, and mineral metabolism, manifested by decreased total protein and globulins and increased cholesterol, triglycerides, uric acid, and ALT activity.

3. Inclusion of 1% Cambrian clay in the diet improved productive performance, partially normalized intestinal microbiocenosis, and stabilized biochemical blood parameters in chickens, indicating the prospects of its use as a natural enterosorbent.

References

1. Jalilzadeh-Amin, G., Dalir-Naghadeh, B., Ahmadnejad-Asl-Ghavaghi, M., Fallah, A. A., & Mousavi Khaneghah, A. (2023). Prevalence and concentration of mycotoxins in animal feed in the Middle East and North Africa (MENA): A systematic review and meta-analysis. *Toxins, 15*(3), 214. https://doi.org/10.3390/toxins15030214

2. Ducatelle, R., Goossens, E., Eeckhaut, V., & Van Immerseel, F. (2023). Poultry gut health and beyond. *Animal Nutrition, 13*, 240–248. https://doi.org/10.1016/j.aninu.2023.03.005

3. Bogach, M. V., Selishcheva, N. V., Bogach, D. M., Perotska, L. V., Bondarenko, L. V., Bohach, O. M., & Kovalenko, O. A. (2025). Porivnialna kharakterystyka mikroskopichnykh hrybiv i mikrobiolohichnoho fonu zernovykh kormiv u spetsializovanykh ta fermerskykh hospodarstvakh na Pivdni Ukrainy. *Veterynarna medytsyna, 111*, 90–96. https://doi.org/10.36016/VM-2025-111-14

4. Ochieng, P. E., Scippo, M. L., Kemboi, D. C., Croubels, S., Okoth, S., Kang'ethe, E. K., Doupovec, B., Gathumbi, J. K., Lindahl, J. F., & Antonissen, G. (2021). Mycotoxins in poultry feed and feed ingredients from Sub-Saharan Africa and their impact on the production of broiler and layer chickens: A review. *Toxins, 13*(9), 633. https://doi.org/10.3390/toxins13090633

5. Ballou, A. L., Ali, R. A., Mendoza, M. A., Ellis, J. C., Hassan, H. M., Croom, W. J., & Koci, M. D. (2016). Development of the chick microbiome: How early exposure influences future microbial diversity. *Frontiers in Veterinary Science, 3*, 2. https://doi.org/10.3389/fvets.2016.00002

6. Shang, Y., Kumar, S., Oakley, B., & Kim, W. K. (2018). Chicken gut microbiota: Importance and detection technology. *Frontiers in Veterinary Science, 5*, 254. https://doi.org/10.3389/fvets.2018.00254

7. Rychlik, I. (2020). Composition and function of chicken gut microbiota. *Animals, 10*(1), 103. https://doi.org/10.3390/ani10010103

8. Garda, S. A., Danilenko, S. G., & Litvinov, G. S. (2014). Biotechnological aspects analysis of agricultural poultry microflora. *Biotechnologia Acta, 7*(4), 25–34. https://doi.org/10.15407/biotech7.04.025

9. Tamchuk, L. M., & Masiuk, D. M. (2024). The modulation of intestinal barrier integrity in broiler chickens is associated with the microbiome changes. *Biolohiia tvaryn, 26*(3), 26–34. https://doi.org/10.15407/animbiol26.03.026

10. Xiao, Y., Xiang, Y., Zhou, W., Chen, J., Li, K., & Yang, H. (2017). Microbial community mapping in intestinal tract of broiler chicken. *Poultry Science, 96*(5), 1387–1393. https://doi.org/10.3382/ps/pew372

11. Bogach, M. V., Selishcheva, N. V., Bogach, D. M., Bondarenko, L. V., & Kolchyk, O. V. (2026). Vplyv toksychnoho kormu na mikrobiotsenoz kyshechnyku ta biokhimichni pokaznyky krovi kurchat. In *Frontiers of Global Knowledge: Proceedings of the International Scientific and Practical Conference* (March 13–15, 2026, Geneva, Switzerland) (pp. 45–53). naukainfo.com. https://doi.org/10.64828/conf-105-2026-1

12. Shen, Y., Fan, N., Ma, S. X., Cheng, X., Yang, X., & Wang, G. (2025). Gut microbiota dysbiosis: Pathogenesis, diseases, prevention, and therapy. *MedComm, 6*(5), e70168. https://doi.org/10.1002/mco2.70168

13. Qiu, P., Ishimoto, T., Fu, L., Zhang, J., Zhang, Z., & Liu, Y. (2022). The gut microbiota in inflammatory bowel disease. *Frontiers in Cellular and Infection Microbiology, 12*, 733992. https://doi.org/10.3389/fcimb.2022.733992

14. Reshetnichenko, O. P., Orlov, L. V., Bogach, M. V., Harbazhii, K. S., & Kriukov, V. (2011). Dobavky dlia bezpechnoi hodivli. *Tvarynnytstvo Ukrainy, 5*, 34–36. http://lib.osau.edu.ua/jspui/bitstream/123456789/861/1/11orresf.pdf

15. Khatoon, A., Khan, M. Z., Abidin, Z. U., Saleemi, M. K., Oguz, H., Gul, S. T., Abbas, R. Z., Ali, A., & Bhatti, S. A. (2024). Aflatoxin B1-associated oxidative stress along with toxicopathological and immunological alterations is efficiently counteracted by dietary supplementation of distillery yeast sludge in broilers. *Mycotoxin Research, 40*(4), 615–629. https://doi.org/10.1007/s12550-024-00549-y

16. Ovcharov, O. V. (2015). Produktyvni yakosti indykiv zalezhno vid dozy u ratsioni tseolitovmisnoho bazaltovoho tufu. In *Materialy mizhnarodnoi naukovo-praktychnoi konferentsii* (pp. 190–191). https://aminbiol.com.ua/20153pdf/21.pdf

17. Damato, A., Cardin, R., & Geraci, C. (2022). Comprehensive review on the interactions of clay minerals with animal physiology: Challenges and opportunities for their use as feed additives. *Frontiers in Veterinary Science, 9*, 889612. https://doi.org/10.3389/fvets.2022.889612

18. Ibrahim, I., Natsir, M. H., Sjofjan, O., Djunaidi, I. H., Susilo, A., Rifa'i, M., & Hafsah, H. (2025). Optimization growth performance and intestinal characteristics in broilers through the use of zeolite-based mycotoxin binders. *Journal of Advanced Veterinary and Animal Research, 12*(1), 149–156. https://doi.org/10.5455/javar.2025.l882

19. Papaioannou, D., Katsoulos, P. D., Panousis, N., & Karatzias, H. (2005). The role of natural and synthetic zeolites as feed additives on the prevention and/or the treatment of certain farm animal diseases: A review. *Microporous and Mesoporous Materials, 84*(1), 161–170. https://doi.org/10.1016/j.micromeso.2005.05

20. DSTU 3570-97 (HOST 13496.7-97). (1999). *Zerno furazhne, produkty yoho pererobky, kombikormy. Metody vyznachennia toksychnosti*. Kyiv: Derzhstandart Ukrainy.

21. Reitman, S., & Frankel, S. (1957). A colorimetric method for the determination of serum glutamic oxaloacetic and glutamic pyruvic transaminases. *American Journal of Clinical Pathology, 28*(1), 56–63.

22. Moskalenko, V. F., Hulchii, O. P., Holubchykov, M. V., Liedoshchuk, B. O., Liekhan, V. M., Ohniev, V. A., Lytvynova, L. O., Maksymenko, O. P., & Tonkovyd, O. B. (2009). *Biostatystyka*. Kyiv: Knyha plius.

Deutsche internationale Zeitschrift für zeitgenössische Wissenschaft
• • •
№129 2026

German International Journal of Modern Science
• • •
№129 2026

Deutsche internationale Zeitschrift für zeitgenössische Wissenschaft ist eine internationale Fachzeitschrift in deutscher, englischer und russischer Sprache.

Periodizität: 24 Ausgaben pro Jahr
Format - A4
Alle Artikel werden überprüft.
Freier Zugang zur elektronischen Version des Journals

German International Journal of Modern Science is an international, German/English/Russian/Ukrainian language, peer-reviewed journal.

Periodicity: 24 issues per year
Format - A4
All articles are reviewed.
Free access to the electronic version of journal.

- Edmund Holst (Salzburg) AT
- Michaela Meissner (Köln) DE
- Klara Amsel (Liège) BE
- Briana French (Cambridge) GB
- Joleen Parsons (Manchester) GB
- Dragomir Koev (Sofia) BG
- Stanislav Štěpánek (Praha) CZ
- Valeriya Kornilova (Kyiv) UA
- Dmitriy Aksenov (Lviv) UA
- Valentin Bragin (Moscow) RU
- Mirosław Bednarski (Warsaw) PL
- Daniela Villa (Florence) IT
- Mattia Molteni (Rome) IT
- Sylwia Krzemińska (Ljubljana) SI
- Käte Kraus (Vienna) AT
- Eleonora Lehmann (Berlin) DE
- Alexander Dressler (Marseille) FR
- Zdzisław Małecki (Warsaw) PL
- Adrián Borbély (Budapest) HU

- Edmund Holst (Salzburg) AT
- Michaela Meissner (Köln) DE
- Klara Amsel (Liège) BE
- Briana French (Cambridge) GB
- Joleen Parsons (Manchester) GB
- Dragomir Koev (Sofia) BG
- Stanislav Štěpánek (Praha) CZ
- Valeriya Kornilova (Kyiv) UA
- Dmitriy Aksenov (Lviv) UA
- Valentin Bragin (Moscow) RU
- Mirosław Bednarski (Warsaw) PL
- Daniela Villa (Florence) IT
- Mattia Molteni (Rome) IT
- Sylwia Krzemińska (Ljubljana) SI
- Käte Kraus (Vienna) AT
- Eleonora Lehmann (Berlin) DE
- Alexander Dressler (Marseille) FR
- Zdzisław Małecki (Warsaw) PL
- Adrián Borbély (Budapest) HU

Artmedia24

Anschrift: Industriestraße 8,74589 Satteldorf Deutschland.

E-mail: info@dizzw.com
WWW: www.dizzw.com

Chefredakeur: Reinhardt Roth

Druck: Einzelfirma Artmedia24, Industriestraße 8,74589 Satteldorf Deutschland

Artmedia24

Address: Industriestrasse 8,74589 Satteldorf Germany.

E-mail: info@dizzw.com
WWW: www.dizzw.com

Editor in chief: Reinhardt Roth

Printing: Artmedia24, Industriestrasse 8,74589 Satteldorf Germany.

Der Redaktionsausschuss der Zeitschrift ist nicht verantwortlich für die veröffentlichten Materialien.

Für den Inhalt der Artikel sind die Autoren verantwortlich
Die Meinung der Redaktion spiegelt nicht unbedingt die Meinung der Autoren wider.

Bei Nachdrucken muss die Zeitschrift zitiert werden.

Das Material wird im eigenen Wortlaut des Autors veröffentlicht.

Editorial board of journal is not responsible for the materials published there.

Authors are responsible for the content of articles.

Opinion of editorial board may not coincide with the opinion of authors.

In case of materials reprinting - link to journal is required.
Materials are publishing in author's edition.

ISSN (Print) 2701-8369

ISSN (Online) 2701-8377

Edition: № 129/2026 (May) – 129th

Passed in press in May 2026

Printed in May, 2026

Printing: Artmedia 24, Industriestrasse 8,

74589 Satteldorf, Germany.

© Artmedia24

© Deutsche internationale Zeitschrift für zeitgenössische Wissenschaft / German International Journal of Modern Science